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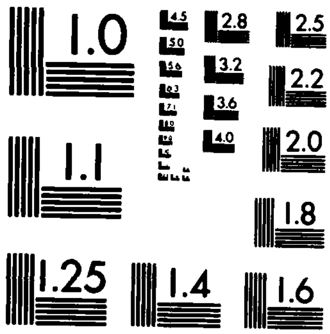

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THESIS

MASK:
A TACTICAL AID FOR PLANNING AIR STRIKES
AGAINST RADAR DEFENDED LAND TARGETS

by

Dana Bruce McKinney

September 1983

Thesis Advisor: A. F. Andrus

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This thesis presents an interactive computer program called MASK which generates radar and optical line-of-sight coverage envelopes based on terrain masking and refractive propagation effects. MASK is designed primarily as an aid in planning air strikes against radar defended land targets and has additional applications to air defense network planning. A large digital terrain data base provides extensive coverage of potential areas of interest to the tactical planner.

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MASK:
A Tactical Aid for Planning Air Strikes Against Radar Defended Land Targets

by

Dana Bruce McKinney
Commander, United States Navy
B.A., University of California, Berkeley, 1969

Submitted in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE IN OPERATIONS RESEARCH

from the

NAVAL POSTGRADUATE SCHOOL
September 1983

Author: ______________________

Approved by: ______________________
Thesis Advisor

____
Second Reader

____
Chairman, Department of Operations Research

____
Dean of Information and Policy Sciences

ABSTRACT

This thesis presents an interactive computer program called MASK which generates radar and optical line-of-sight coverage envelopes based on terrain masking and refractive propagation effects. MASK is designed primarily as an aid in planning air strikes against radar defended land targets and has additional applications to air defense network planning. A large digital terrain data base provides extensive coverage of potential areas of interest to the tactical planner.

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I. INTRODUCTION

A. HISTORICAL PERSPECTIVE

In the last decade, tactical planners have witnessed a revolution in the development and deployment of air defense systems. The increasing number and effectiveness of the weapons introduced into the inventories of potential adversaries have greatly complicated the task of today's tactical strike planner. The primary objective of timely delivery of ordnance on target has been increasingly challenged by the ability of an adversary to impose an unacceptably high attrition rate on the attacking forces. The deployment of modern air defense systems in some areas of the third world has contributed to instability by calling into question the ability of the Carrier Battle Group to project power ashore.

Due to the risk involved in directly engaging a modern air defense network, additional emphasis has been placed on methods of reducing the amount of time that attacking aircraft must spend in the threat weapon envelope. These methods generally include the use of stand-off weapons, electronic countermeasures and low altitude penetration tactics. The success of low altitude penetration tactics rests on the ability of the attacking force to use terrain masking to delay initial detection and thereby reduce the time for the defense to effectively react. Effective employment of terrain masking is a concept which is likely to play an important role in future strike planning regardless of the air defense threat.

The increasing threat to our strike forces has spurred the development of more effective methods of neutralizing enemy defenses. Attacking aircraft

have more capable weapon systems, electronic warfare support has increased and real-time intelligence and surveillance capabilities have improved. However, our ability to accurately and rapidly assess the effect of terrain on the strength of enemy defenses has not progressed. This shortcoming limits the ability of the planner to employ his assets to the maximum advantage. This is especially true in situations requiring a quick reaction to a present threat. In such a situation, the tactical planner is forced to make extremely important decisions based on a gross estimation of the effects of terrain masking. The current state of the art is limited to the use of aeronautical or topographic charts to get an estimation of the threat system coverage envelope. Lines of sight, if plotted, are manually computed and based on the most rudimentary calculations. In short, the process is tedious, time consuming and inadequate. The importance of an accurate estimation of the enemy defensive coverage cannot be overstated. This information will ultimately determine the mission profile of the entire strike including cruising altitudes, routes of flight, low altitude penetration descent points, electronic countermeasures employment, fuel requirements and carrier aircraft launch position. In the absence of better information, the planner often assumes "worst case" conditions and limits the aggressive employment of his assets. Overly optimistic assumptions have more serious consequences.

B. RECENT DEVELOPMENTS

The need to upgrade tactical planning capabilities has been recognized by the fleet. The introduction of the Integrated Refractive Effects Prediction System (IREPS) into the fleet was a major step in improving the tactical planning process, especially in the War-at-Sea scenario. IREPS provided a real-time onboard capability to predict radar coverage and propagation anomalies

caused by the atmosphere. In particular, identification of the effect of surface based ducting on low altitude radar effectiveness was of great tactical importance. In many situations it became apparent that the selection of extremely low altitude attack profiles increased, rather than decreased, detection ranges against attack aircraft over water. The potential of IREPS and the nearly simultaneous development of a program by the Defense Mapping Agency Aerospace Center (DMAAC) to produce a world-wide Digital Terrain Elevation Data (DTED) base led logically to an idea called the Radar Detection Analysis System (RDAS). RDAS was put forth as an operational requirement from the fleet in June 1981 and envisioned a system incorporating the capabilities of IREPS, the data resources of the DTED and radar order-of-battle information supplied by already existing intelligence sources. Although several candidate systems have been developed to date, the fleet is still without the capabilities described in RDAS. At present, the most promising system is the Computer Aided Mission Planning System (CAMPS). Current information is that some CAMPS units are included in POM 85, but it is not possible to forecast the point at which this crucial capability will become operational throughout the fleet.

One final development should be mentioned. This is the impressive growth in computing power afforded by the introduction of the modern "desk top" computer. Units scheduled for near term fleet introduction, such as the Hewlett-Packard HP 9000, have a vastly greater capability for executing complex programs than did their immediate predecessors. In light of this imminent leap in shipboard computing power, it is now feasible to develop sophisiticated computer programs for future fleet use.

C. THESIS OBJECTIVE

The objective of this thesis is to develop a computer program to provide a shipboard terrain masking prediction capability pending the introduction of systems such as CAMPS. The program, MASK, incorporates terrain masking calculations based on DTED and includes anomalous propagation effects based on data derived from IREPS outputs. The design of MASK will allow it to be easily modified to run on systems such as the HP 9000 which have a baseline 500 KBYTE core memory and the ability to run a FORTRAN program using the UNIX operating system. MASK is currently running on the IBM 3033 using FORTRAN IV and the CMS operating system.

It is worth pointing out at this time that MASK is not a radar range prediction device. Radar detection range determination is dependent on many variables, some of which are time and route dependent (radar cross section as a function of relative aspect angle) or are dependent on operator fatigue or alertment. MASK is a deterministic model which calculates the ability of a given threat to have a clear line-of-sight in the direction of a target at a given altitude and range under specified atmospheric conditions. A predetermined flight path is neither required nor desired for MASK to carry out its calculations. The output from MASK graphically shows the vulnerable areas in the enemy defense network. Identification of these areas forms the basis upon which the rest of the planning evolution must ultimately rest.

D. APPLICATIONS

The primary application of MASK is in air strike planning. A brief examination of the MASK output will reveal any areas of inadequate enemy radar coverage. By choosing routes of flight which take advantage of these areas, the planner will increase the survivability and effectiveness

of his attacking aircraft. MASK will allow attacking forces to choose descent points so as to take advantage of efficient cruising altitudes for as long as possible, descending only when required to remain "unseen". Preflight coordination of jamming and anti-radiation missile assets will also be enhanced by having a more realistic idea of the radar envelope, rather than just a circle of coverage centered on the victim radar.

A change of viewpoint leads to MASK's application to improving the air defense posture of friendly forces. MASK will allow the air defense network planner to easily assess his area coverage and to relocate or add assets to fill any voids. In the amphibious assault scenario, MASK will permit the planner to survey potential defensive missile battery locations prior to landing and allow rapid deployment of an air defense perimeter "tailor-made" for the local terrain. The time saved in setting up an organic land-based air defense system will mean that supporting missile ships can leave the landing area sooner, decreasing their vulnerability to attack and increasing overall tactical flexibility.

II. PROBLEM STATEMENT

A. GENERAL

The central problem in the terrain masking calculation is to define the position of an observer (the radar) and a candidate point and then to ask the question, "Is there any part of the earth's surface which interrupts the line of sight between the two?". Once this question is answered, an adjacent candidate point is chosen and the question is repeated and so on. Eventually, all candidate points are investigated and all those points for which the answer is "yes" form the set of masked points. All other points are unmasked and the boundary between the two sets defines the terrain masking envelope.

It should be understood that this model is not designed to include propagation loss factors or radar maximum detection range limits. The only range limit imposed which is not related to terrain masking is the maximum unambiguous range as a function of pulse repetition frequency (PRF).

B. OBSERVER POSITION

The first consideration is to define the position of the observer. In this case the observer is a radar site with a known geographic location in terms of latitude, longitude and elevation. The observer's latitude and longitude are defined in terms of position (I,J) in a square matrix and the observer's elevation is the value of that matrix element. The observer will then be located at or above the matrix element (I,J) depending on the local terrain elevation value. For simplicity in this

discussion it is assumed that when locating an observer in the matrix, all observers are well behaved and only exist in the real world at the exact location where a matrix element exists in the model. In practice, allowances must be made for perverse observers who violate this assumption.

C. PLANE EARTH LINE-OF-SIGHT

Given an observer location and the location of a candidate point (CP) above matrix element (M,N), the line-of-sight can be defined. In a simple world, line-of-sight would be a straight line between the observer and the CP. The real world is not so simple, but for now it is assumed that the earth's surface is a plane and that it exists in a vacuum. This allows the curvature of the earth and the effects of atmospheric refraction on the propagation of radar and light waves to be ignored. In this initial model the line-of-sight between the observer and the CP can be defined by two values. The first value, which is called horizontal slope (SH), is the geometric slope of the line from (I,J) to (M,N). Determination of the horizontal slope is shown in Figure 2.1. The second value, which is called vertical slope (SV), is the angular (radian) measure of the "look up" or "look down" when the observer points at the CP. For example, if the observer were located in a valley and the CP were on a hill SV would be positive. If the observer and CP exchanged places SV would be negative, and if they were at the same elevation SV would equal zero. Determination of the vertical slope is shown in Figure 2.2.

D. OBSTRUCTIONS

Having defined line-of-sight, the location of any obstructions between the observer and the CP must be determined. One method of accomplishing

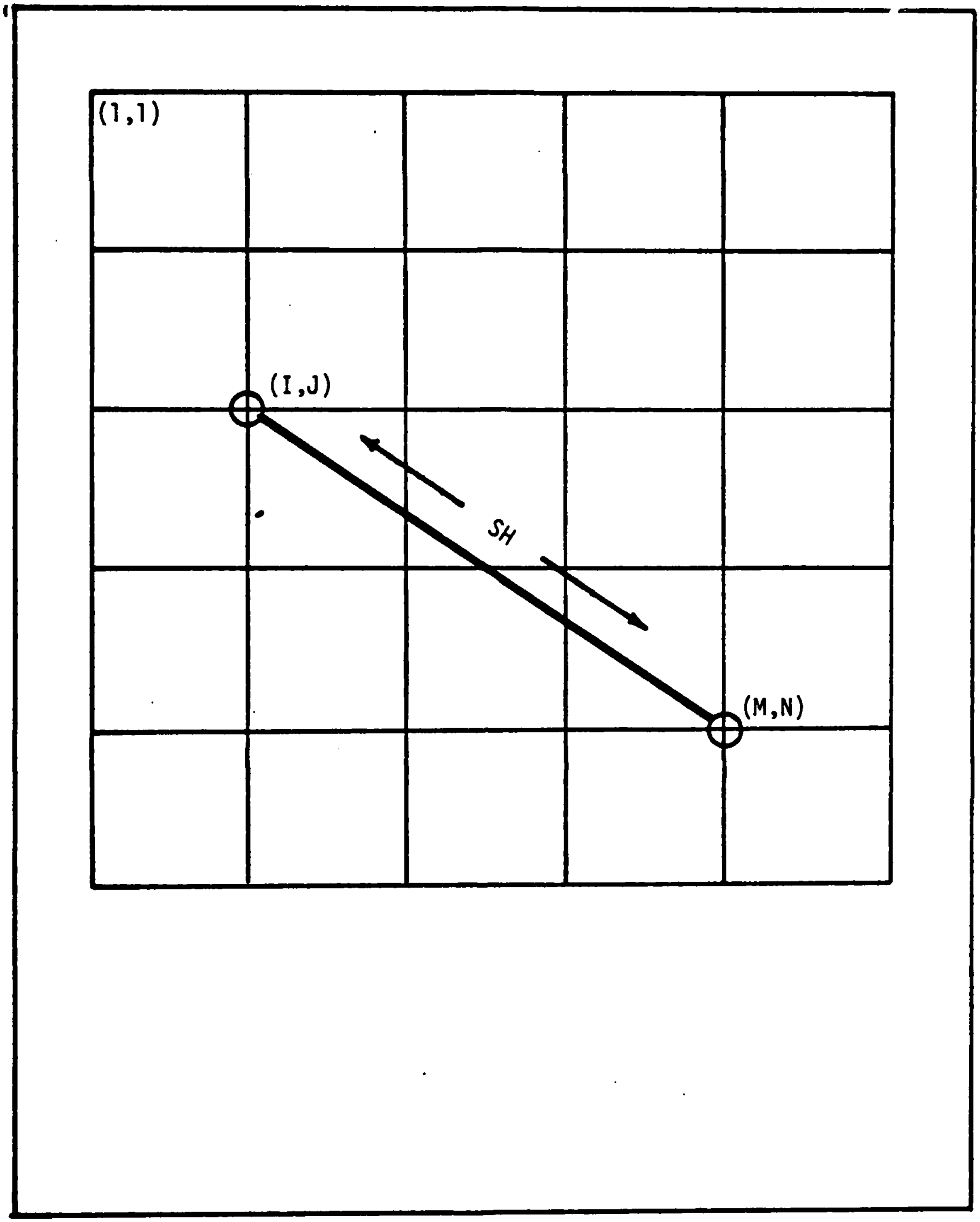


Figure 2.1 Determination of Horizontal Slope

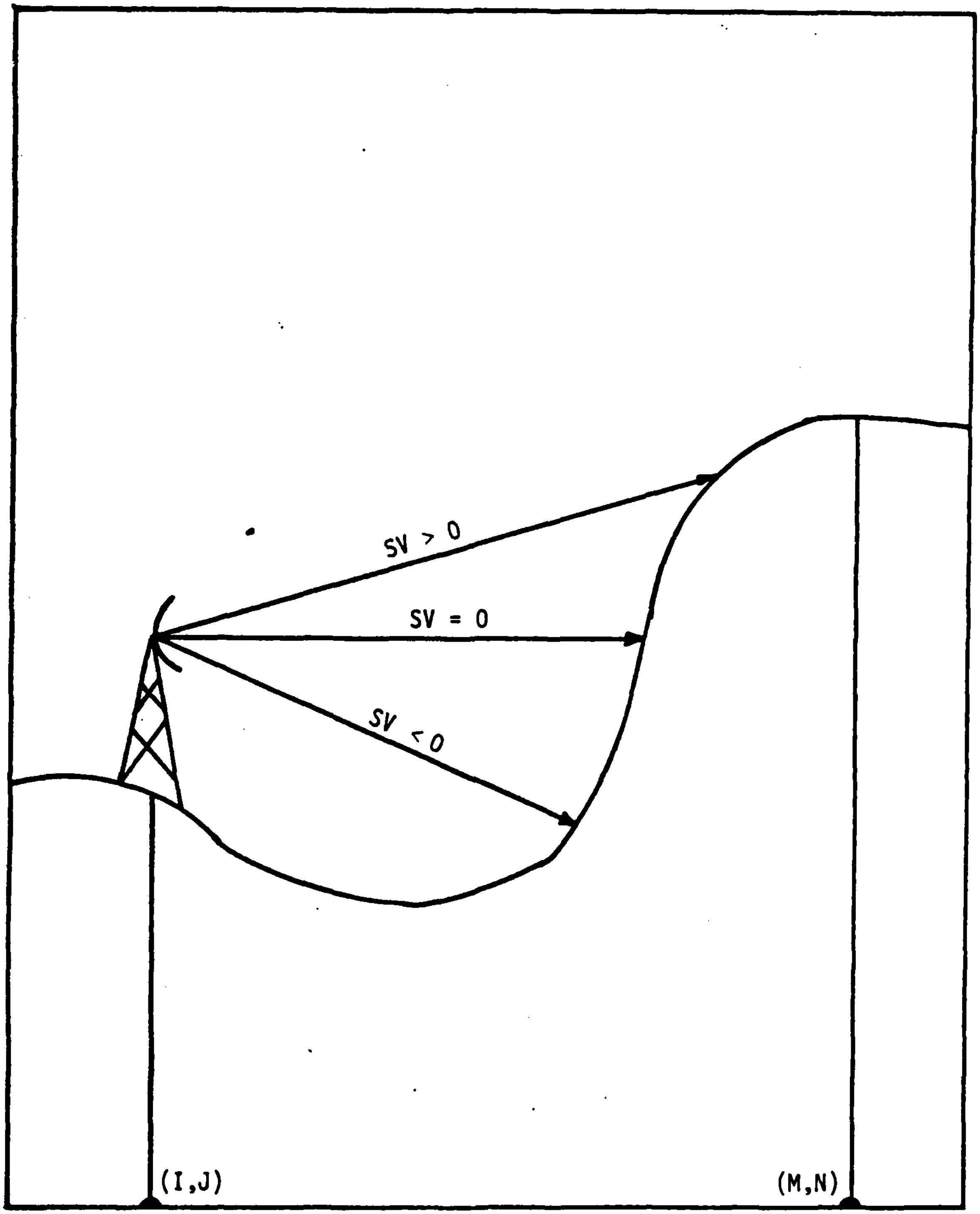


Figure 2.2 Vertical Slope Determination

this is to travel along the line from (M,N) to (I,J), sampling matrix elevation values to determine the SV at each sampling point (X,Y). As sampling progresses, only the largest (i.e., most positive) angle is saved. The largest value of SV for all sample points along the line is called the maximum vertical slope angle (MAXV) and is the elevation angle from the observer to the top of the (apparently) tallest object on the line from (I,J) to (M,N). This is illustrated in Figure 2.3. If a line is extended outward from the observer with elevation angle MAXV it will pass over (M,N) at some height above the plane of the matrix. This "masking height" is then compared with the specified height of a given target above (M,N). If the target height is below the masking height the target is masked by terrain. Otherwise, the target is visible to the observer. Once the condition of a target above (M,N) is determined, an adjacent element is chosen as the next CP. This process is duplicated for each matrix element.

E. EXTENSION TO SPHERICAL MODEL

Now that the problem has been defined in the simple case, two major complications must be introduced to provide a realistic model.

1. Refractive Effects

The first complication is the phenomenon of the refraction of radar (and to a lesser extent, light) waves by the atmosphere. The result of refraction is that waves in the atmosphere tend to follow propagation paths which are curved rather than straight lines. The magnitude and direction of path curvature is determined by the rate of change with respect to height of the refractive index of the atmosphere (dn/dh). The index of refraction, n, is a function of pressure, temperature and humidity and, in

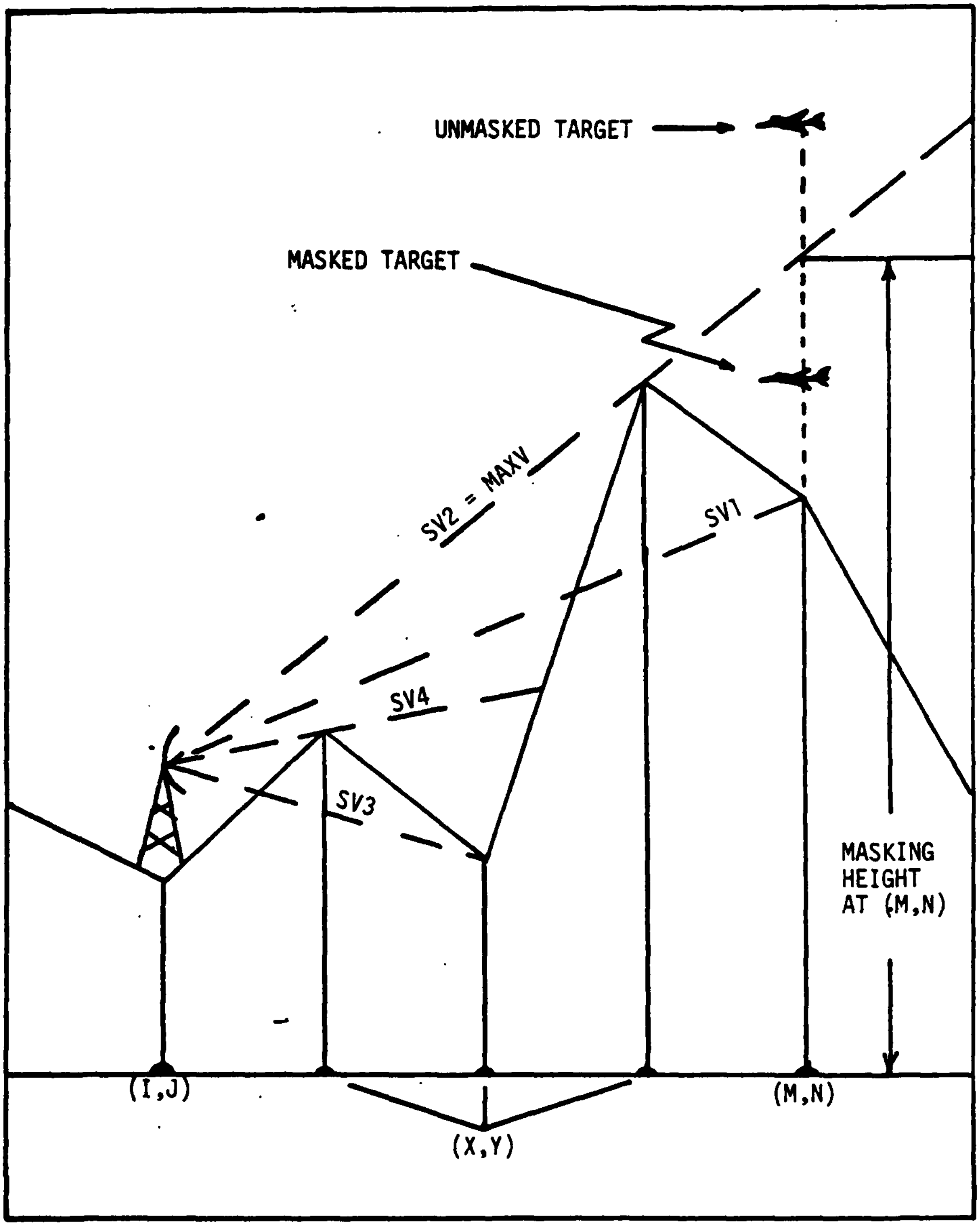


Figure 2.3 Masking Height Determination

most cases, is a decreasing function with respect to height. By using Snell's Law it can be shown that the radius of curvature, R, of the refracted wave path is given by equation 2.1.

$$R = -1/(dn/dh) \qquad \text{(eqn. 2.1)}$$

The derivation may be found in [Ref. 1: p 48]. For standard values of dn/dh (approximately -0.0000392 per kilometer), R has a value of 25510 kilometers or about four times the radius of the earth. This results in radar waves propagating along paths which usually curve in the same direction as the curvature of the earth's surface, but which do not intersect it.

Certain atmospheric conditions generate values of dn/dh which can produce anomalous propagation paths. In extreme cases, R takes on values which are less than the earth's radius, causing the waves to curve back and intersect the surface. The wave is then partially reflected back into the atmosphere and continues in this way to "skip" along the surface of the earth for long distances. This effect is called ducting and can result in greatly extended radar ranges, especially over water. In less extreme cases, the ray paths may have greater than normal curvature but fail to return to earth. This condition, called superrefraction, can still produce over-the-horizon radar ranges. A value of dn/dh equal to zero equates to a radius of curvature which is infinite, producing straight line propagation and positive values of dn/dh actually yield ray paths which curve away from the earth. This latter condition is called subrefraction and is very rare.

For convenience the term, N, has been used to equal (n-1) x 1,000,000. For example, the use of this transformation gives a value for dN/dh of -39.2 'N' units' per kilometer of altitude on a standard day.

Figure 2.4 shows a graphic representation of the types of refractive effects discussed and a table relating dN/dh to the refractive types.

It should be obvious from this discussion that refractive effects must be accounted for in terrain masking calculations due to their influence on the curvature of the line-of-sight.

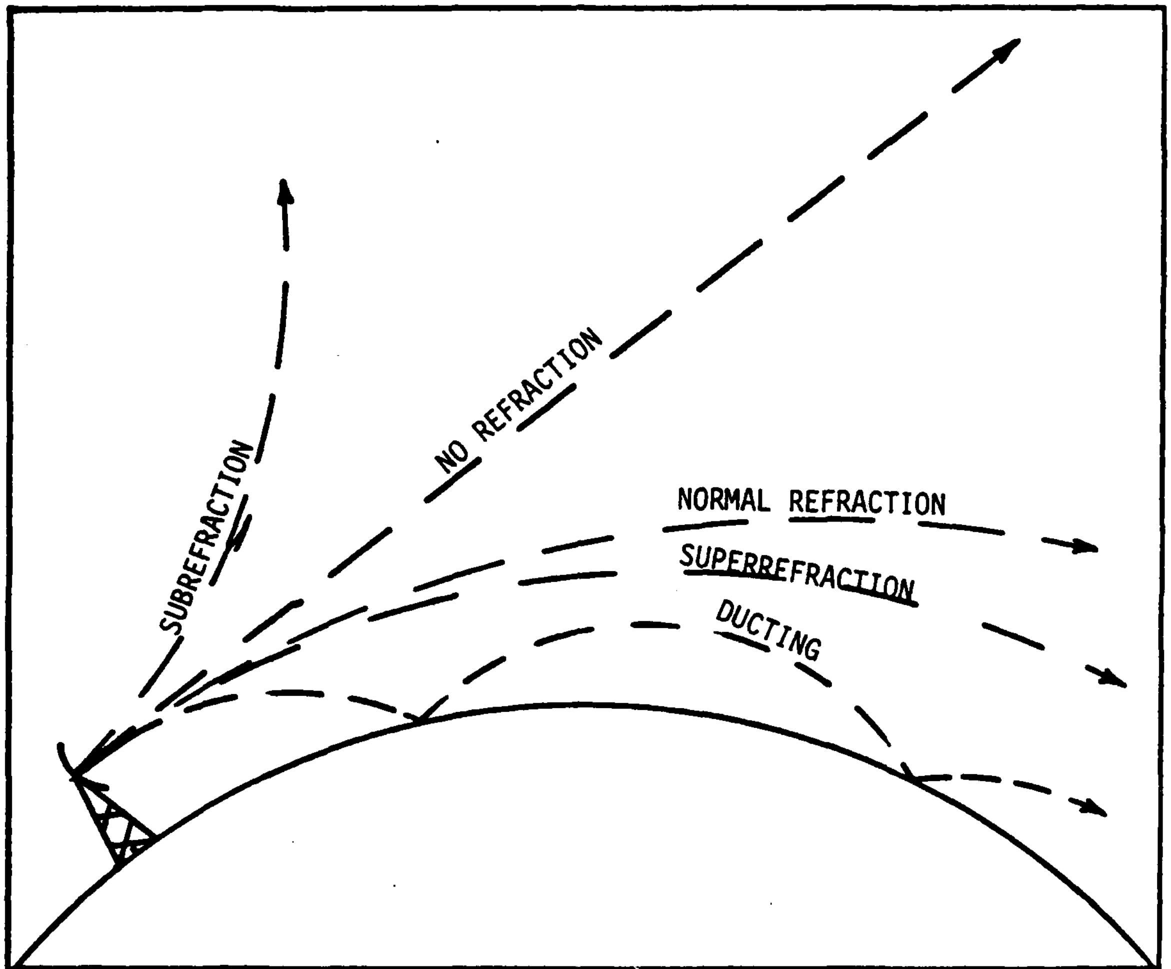
2. Earth Curvature

The second complication is that the earth's surface is not a plane. It has a complex elliptical shape which can be approximated in this application by a sphere with a radius equal to roughly 6370 kilometers. The resulting curvature causes the apparent line-of-sight (as viewed from a "plane earth" perspective) to bend away from the surface. As a result, the use of a spherical earth model profoundly affects the determination of the elevation angle, MAXV.

The introduction of refraction and earth's curvature naturally complicates the problem at hand. While the simpler model involved straight line ray propagation over a plane, the more complex one deals with curvilinear propagation over a spherical surface. Fortunately, there is a method of combining these two problems and obtaining a simplified equivalent one. The derivation of this method is not presented here, but the end result will be used (for the complete derivation, see [Ref. 1: pp 45-48]). The method allows plotting the line-of-sight as a straight line provided a larger "equivalent radius" is used in place of the actual earth radius. This is illustrated in Figure 2.5. This method also assumes that the atmosphere is homogeneous with a constant value of dn/dh. The equivalent radius, RE, is given by equation 2.2,

$$RE = a/(1+(a \times (dn/dh))), \qquad \text{(eqn. 2.2)}$$

where a is the actual earth radius. This equation allows the use of dn/dh to arrive at an equivalent earth radius which accounts for both refractive



dN/dh	TYPE REFRACTION	RANGES
> 0	SUBREFRACTION	SHORT
0 → -79	NORMAL	NORMAL
-79 → -157	SUPERREFRACTION	LONG
< -157	DUCTING	EXTREME

Figure 2.4 Refractive Propagation Paths

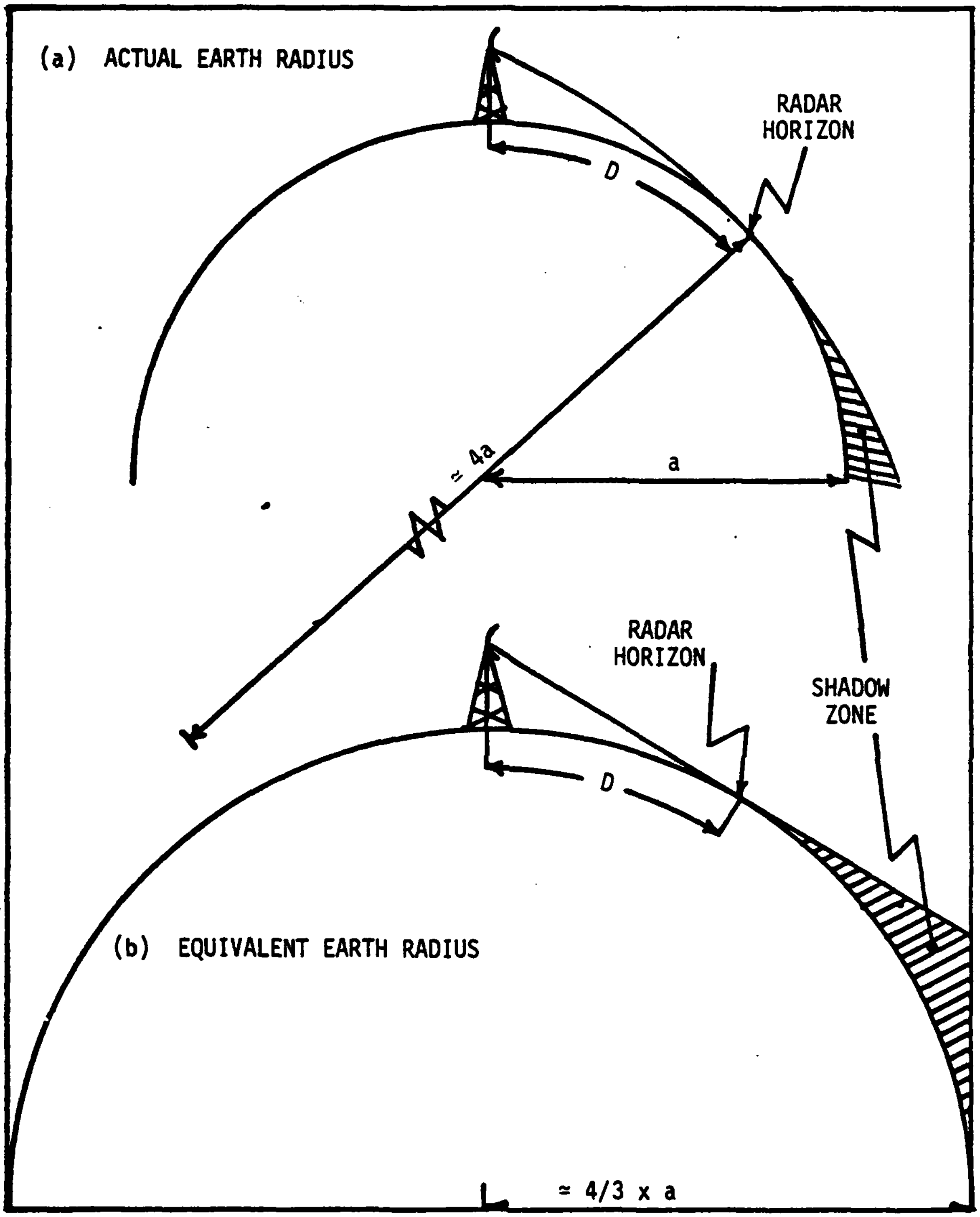


Figure 2.5 Actual and Equivalent Earth Comparison

and earth curvature effects and which leads to a convenient way of modifying the flat earth model.

3. Spherical to Planar Transformation

The use of equivalent earth radius provides a means of accounting for the effects of refraction and earth curvature at the same time. However, it introduces the problem of dealing with a spherical earth's surface. As a result, determination of the angle, SV, is made more difficult than in the flat earth model. One way to retain the benefits of the equivalent earth radius model and still deal in planar coordinates is to transform the spherical surface into an equivalent plane while preserving the angular relationships. During the following discussion, it will be helpful to refer to Figure 2.6.

The transformation to planar coordinates essentially involves a reduction in the height of the radar antenna (h1) and the sample terrain height (h2) above (X,Y), as well as increasing the distance between (I,J) and (X,Y). The cosine of ALPHA yields the reduced heights, h1' and h2', while the sine of ALPHA leads to the calculation of the increased distance, D', between (I,J)' and (X,Y)'. The signed difference between h2' and h1' is then divided by D' and the arctangent of the result is the angle SV. The angle SV' is obtained by adding pi/2 to SV and subtracting ALPHA. SV' is the radian measure of the elevation of the line of sight between the radar antenna, A, and the obscuring terrain, O, relative to the vertical line from (I,J) to the earth's center, C. The determination of MAXV is performed just as in the flat earth model except that the maximum value of SV' is retained as the sampling proceeds from (M,N) to (I,J).

At this point all of the information requried to determine the masking height, MHM, above (M,N) is available. Figure 2.7 shows the pertinent relationships. MAXV has already been found, and BETA is calculated

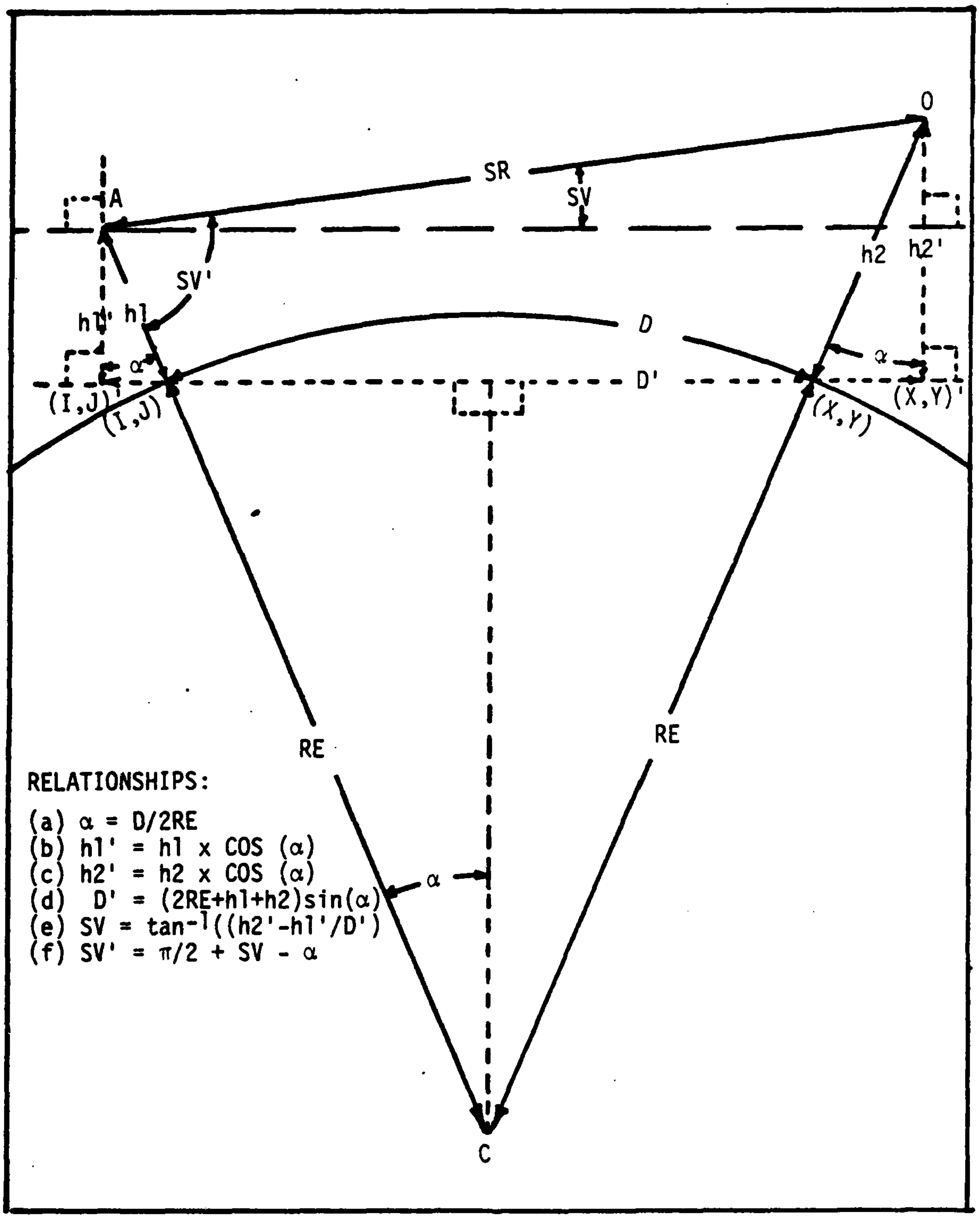


Figure 2.6 Calculation of Vertical Slope at (X,Y)

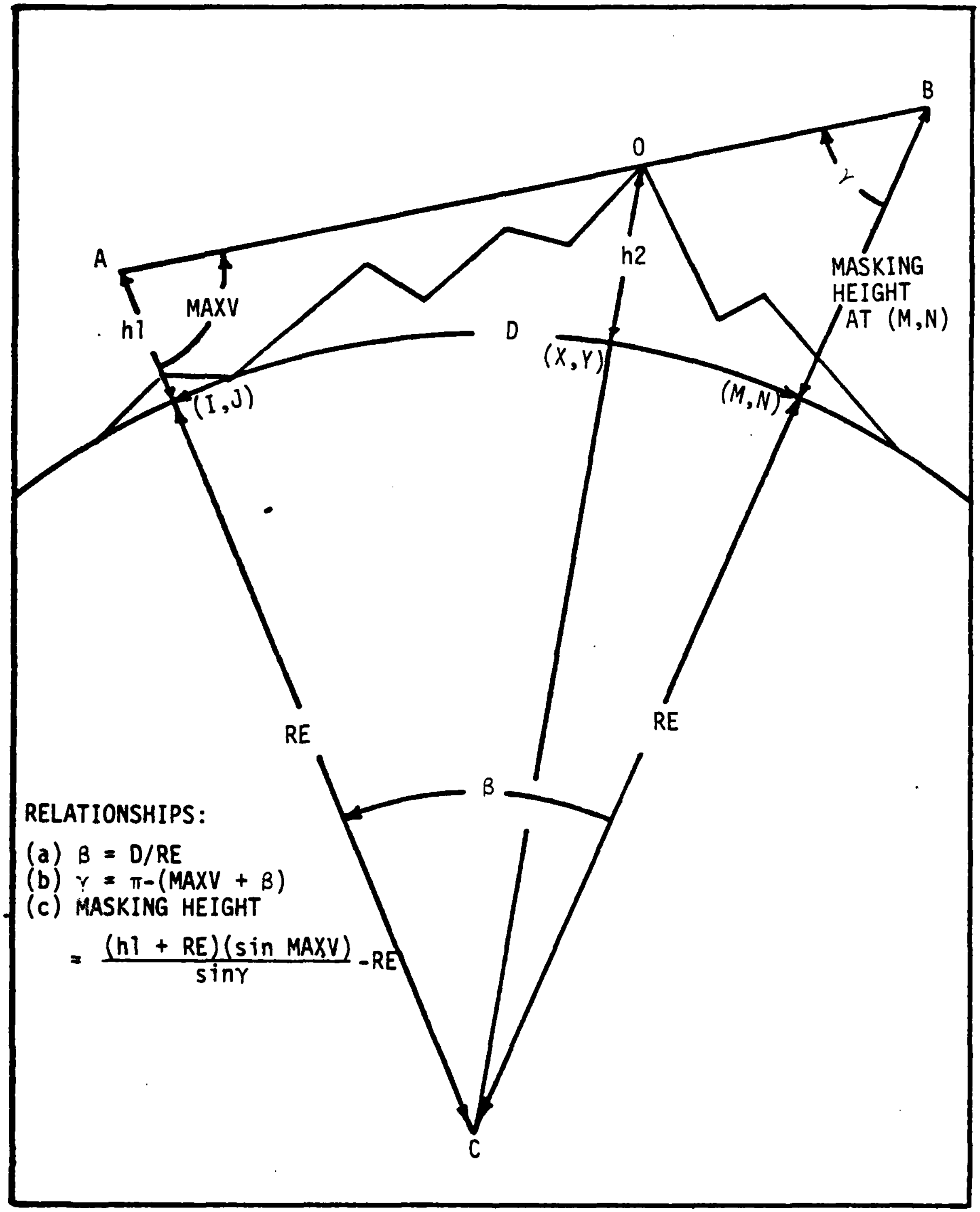


Figure 2.7 Calculation of Masking Height at (M,N)

by dividing D, the ground distance from (I,J) to (M,N), by the equivalent radius, RE. GAMMA is obtained by inspection and the Law of Sines is applied to the side AC to obtain the length of BC. The comparison of MHM is performed as in the flat earth model and the masking indicator variable is saved for later display.

The process described above is systematically applied to the entire matrix, producing the masking envelope for the first observer. The sequence is then repeated for each additional observer located in the matrix. Figure 2.8 shows a simplified flow chart of the required steps in the masking calculation process.

4. Reflection

A final point should be mentioned in passing. In radar propagation models for shipboard systems one of the primary concerns is the modification of the received signal energy due to reflection from the sea surface. This effect is primarily caused by constructive and destructive interference resulting from phase differences in the received signal at the antenna. This interference causes the formation of lobes of increased and decreased detection ranges and can significantly affect the performance of shipboard weapon systems. However, since this model is primarily concerned with landbased systems, reflective effects have been ignored. Overwater propagation effects, including reflection, have been treated extensively in the IREPS model which is already widely deployed.

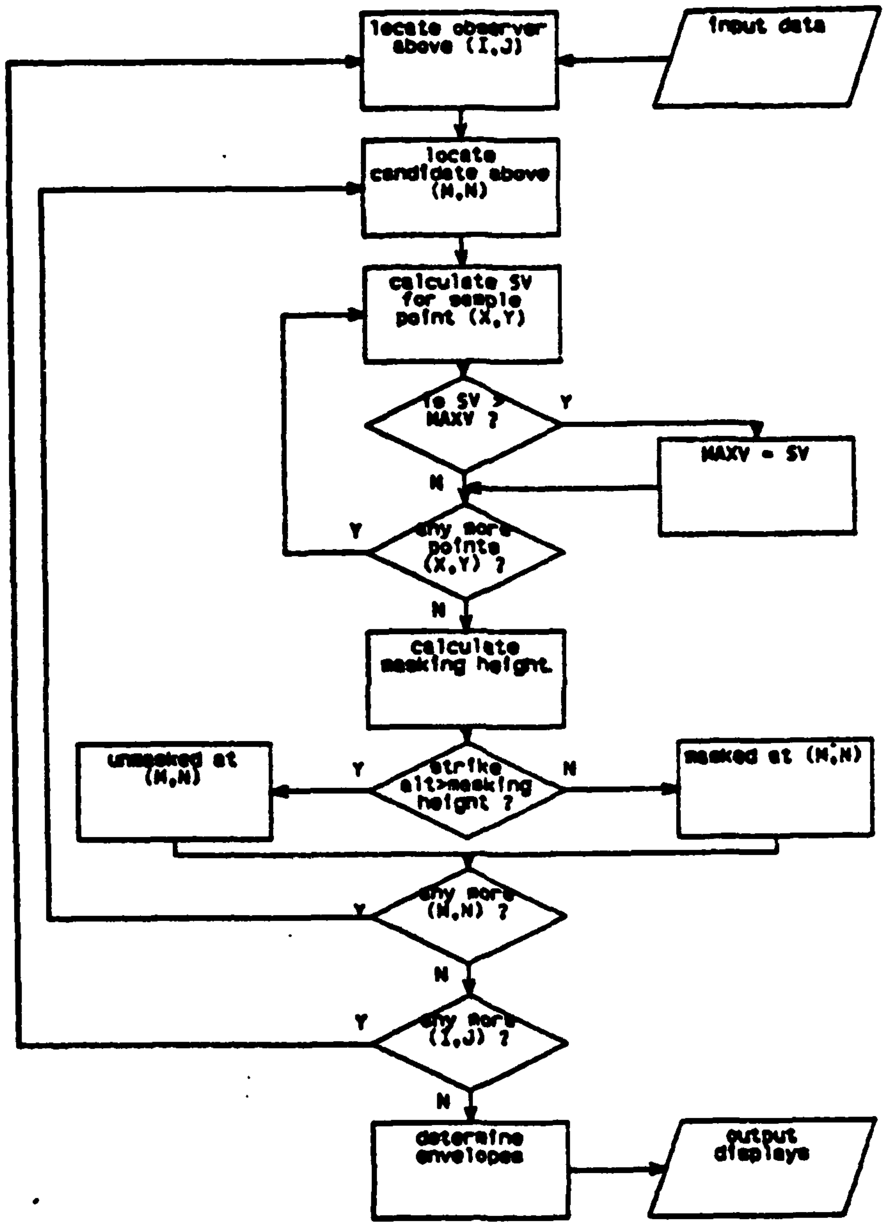


Figure 2.8 Flow Chart of Masking Calculation Process

III. PROBLEM SOLUTION

A. OVERVIEW

This chapter will present an overview of the steps used in MASK to derive terrain masking envelopes. The steps involved are best examined by separating them into the three general areas of input, mathematic calculations and output.

Input starts with the standard DTED description, follows through data base transformations and concludes with determination of the relative positions of the radar sites and targets. In addition, inputs related to radar system characteristics, strike variables and atmospheric conditions are included.

The mathematic model phase begins with all initial conditions established. The math model takes the input data and performs the calculations required to determine whether or not a given point in space is in an unobstructed line of sight from the radar site. The end result is a binary indicator variable which is used in the output phase to display a masked or unmasked condition.

The output phase is concerned primarily with three map displays. The first is a topographic picture of the area in question and is alphabetically coded by elevation. This display is the link between the planner's view of the world and the masking envelopes which follow. It provides the geographic landmarks and scale indicators which make the masking envelopes useable as planning tools. The final two displays are the actual masking envelopes. There is one display based on a selected strike cruising altitude referenced to mean sea level (MSL) and one for the strike in the terrain following mode whose altitudes are referenced to height above ground level (AGL).

B. INPUT PHASE

1. Terrain Data

The data base for all terrain elevation values used by MASK is the DTED produced by DMAAC. The objective of the DTED program is to digitally map the entire terrain surface of the earth. The current status of completed mapping is available in [Ref. 2].

The elevation reference for the DTED is Mean Sea Level (MSL) and the horizontal location of terrain is referenced to the World Geodetic System. All terrain elevation values are signed magnitude, sixteen-bit (two word) binary integers representing elevation in meters above MSL. The DTED is distributed on a subscription basis to a number of DOD users and is unclassified. Standard tapes are nine track, 1600 FPI/phase encoded and use ASCII code for tape labels. Complete tape specifications are contained in [Ref. 3].

The basic unit of DTED is the data file. Each data file contains the elevation data for a one degree square of the earth's surface. The reference for all data in the file is the latitude and longitude of the southwest corner of the degree square. Within the file, data is divided into records of constant longitude. Each record contains a record location identifier and the terrain elevation values which span the degree square from south to north at the given longitude. The interval between elevation values for the standard DTED is three arc-seconds. In order to provide overlap between adjacent data files an extra elevation value is added to the top of each record. Accordingly, each record contains 1201 individual values (3600 arcseconds per degree divided by three arcseconds per value, plus the overlap). The records

are arranged within the file in a similar manner from west to east so that there are 1201 records spanning the width of the data file including one for overlap. The file is thus arranged so that elevation values are read from south to north within each record and records are read from west to east within the file. Figure 3.1 illustrates the internal structure of a typical data file.

For any location on the earth the standard three arcsecond interval is equivalent to approximately 300 feet (93 meters) of ground distance between elevation values when measured along a meridian (i.e., north to south). At the equator, the longitudinal (east to west) measurement is identical. However, as latitude increases, the distance between elevation points decreases when measured longitudinally. At the poles, of course, this distance shrinks to zero. The effect of this shrinkage is to increase the longitudinal density of the terrain elevation points as they depart from the equator. The relationship between the width (in distance) of a degree square at the equator and one at some other latitude is given by equation 3.1,

$$DL = 60 \times \cos(L), \qquad \text{(eqn. 3.1)}$$

where DL is the width in nautical miles at a given latitude and L is the specified latitude in degrees. This relationship is illustrated in Figure 3.2. Because of this decreasing longitudinal distance at the higher latitudes, the DTED changes the longitudinal interval between values. The first change occurs at 50 degrees north and south where the interval is doubled to six arcseconds. A second change takes place at 75 degrees as the interval again doubles to twelve arcseconds. These changes reduce the number of records in each data file to 601

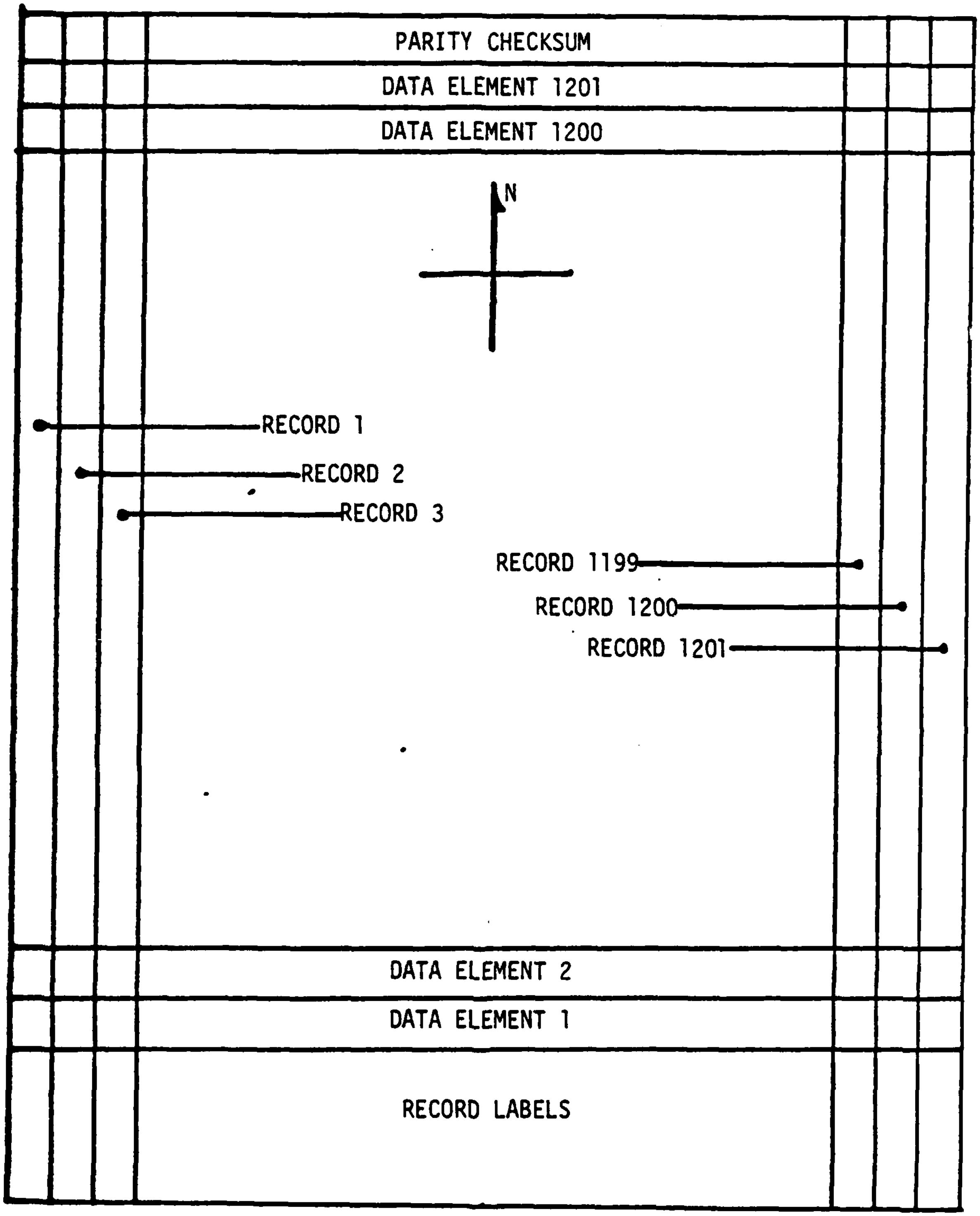
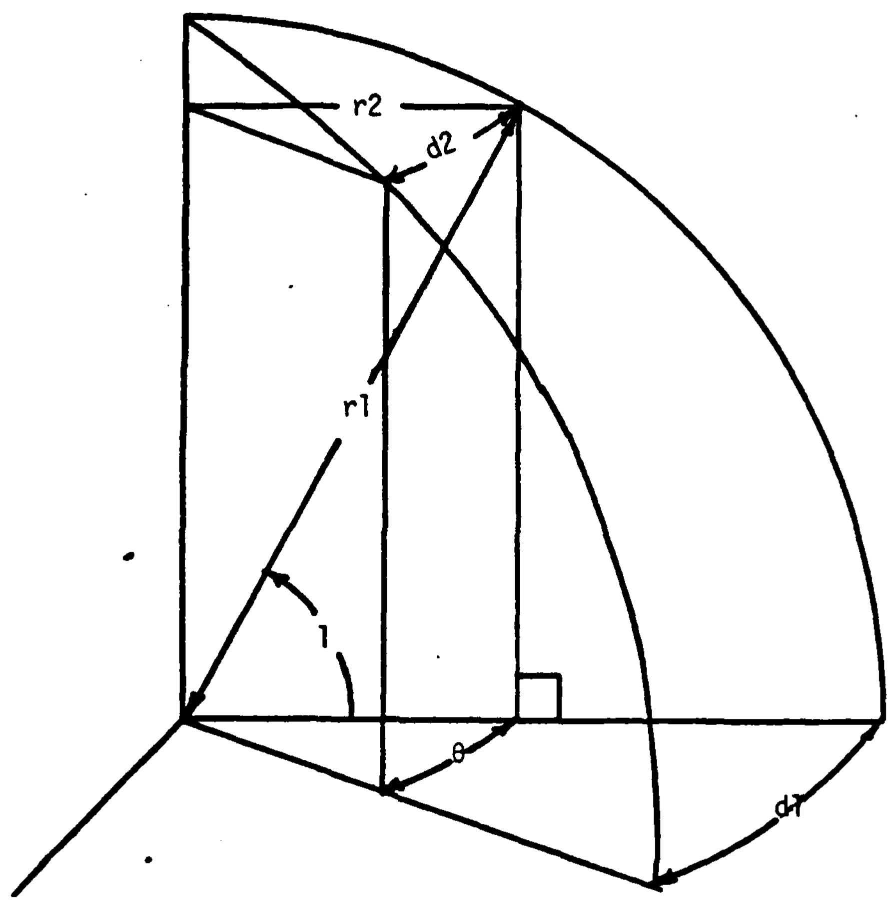


Figure 3.1 Internal Structure of a DTED Data File



RELATIONSHIPS:

d1 = θr1 = 60
d2 = θr2
r2 = r1 cos(1)
d2/d1 = r2/r1 = r1 cos(1)/r1 = cos(1)
d2 = d1 cos(1)
= 60 cos(1)

Figure 3.2 Variation of Longitudinal Distance

above 50 degrees and 301 above 75 degrees. No change is made to the number of elevation values per record, since the meridian distance remains constant for all locations.

In addition to terrain elevation data, each file contains a label identifying its location within the DTED and other administrative information including the accuracy of the data. Accuracy is in terms of a 90 percent probability that elevation errors will not exceed a given value in meters. For a complete explanation of DTED data file structure, see [Ref. 3].

2. Transformations

a. General

An artificial limit was set on the core memory requirements of MASK during its development. This limit is 500 kbytes and was chosen to represent the anticipated capability of desk-top computers projected to be available in the fleet in the near term. The design of MASK requires that a large elevation data matrix and two smaller display matrices be accessible during processing. In order to remain below the core limit the data matrix size was fixed at 400 by 400 elements. Since each element is two bytes long, the data matrix alone requires 320 kbytes of core storage. The storage requirement for a complete DTED data file at the three arcsecond resolution is about 2900 kbytes. It is therefore impossible to access anything more than a fraction of a DTED file at full resolution using MASK.

Obviously, a data transformation of some kind is required for MASK to use the DTED. This transformation is normally accomplished in two steps. First, the DTED file is located and loaded from tape via

MVS to the user's diskfile. This is accomplished using the GETTAPE program which retrieves a specified DTED file and sends it to an MVS file under the name of TAPE DATA. The MVS file is then accessed and TAPE DATA is loaded onto the user's disk. Due to the size of the file a temporary disk must be defined prior to the transfer of TAPE DATA. The second step is to process TAPE DATA through a transformation program called TRANS which produces an output file called MASK DATA. MASK DATA is the 400 by 400 element square data base required by MASK. A third step, which is required if an area larger than one degree is needed, uses a program called COMBIN.

b. Transferring DTED From Tape

The GETTAPE program is a short batch program which retrieves a specified DTED file from tape and transfers it to MVS under the name TAPE DATA. The user must identify the desired file by tape label and file number prior to submitting the GETTAPE program. Each tape contains several miscellaneous administrative files interspersed with the elevation data files. Desired data files may be more easily located by using a program called TSCN, which scans the tape and prints out the contents by file number.

The tapes used in developing MASK cover an area from 46 to 51 degrees north latitude and from 118 to 124 degrees west longitude. This includes most of Washington State and part of southern British Columbia. The tapes are arranged primarily in latitude bands with each tape containing six adjacent one-degree squares. The elevation data files on each tape are numbered, from west to east, 2, 5, 8, 11, 14 and 17. Figure 3.3 shows the areas covered by tape label and file number.

FILE NUMBER → / TAPE LABEL ↓	2	5	8	11	14	17
	LATITUDE AND LONGITUDE OF SOUTHWEST CORNER					
S-795	50 N 124 W	50 N 123 W	50 N 122 W	50N 121W	50N 120W	50N 119W
S-837	49N 124W	-	-	-	-	49N 119W
S-796	48N 124W	-	-	-	-	48N 119W
S-798	47N 124W	-	-	-	-	47N 119W
S-797	46N 124W	46N 123W	46N 122W	46N 121W	46N 120W	46N 119W

Figure 3.3 Geographic Areas by Tape and File Number

c. TRANS

TRANS is the workhorse of the transformation process. It accepts user defined inputs and the TAPE DATA file and produces a 400 by 400 square matrix called MASK DATA which is used by MASK. TRANS prompts the user to input certain required values. These include the latitude and longitude of the southwest corner of TAPE DATA, the southwest corner of the area within TAPE DATA to be transformed and the desired transformation interval.

Since MASK DATA can only hold a 400 square matrix the user must make a tradeoff between resolution and area coverage. If high resolution is required then MASK DATA will use the same three arcsecond interval as TAPE DATA. This necessarily limits the geographic coverage of MASK DATA to twenty minutes on each side. The next larger area covered is 40 minutes square and is obtained by selecting a transformation interval of six arcseconds. During this transformation TRANS deletes half of the elevation values in each record and half the records in the data file. This is equivalent to increasing the distance between elevation data points to about 600 feet. If the entire data file is to be transformed a similar process takes place, except that the interval is increased to nine and more points are deleted.

As previously mentioned, the user must enter the location of the southwest corner of the area to be transformed. If an entire degree is to be transformed this location must necessarily be the same as the southwest corner of the TAPE DATA file. When smaller areas are desired, the user has some flexibility in the selection of the corner point as long as it is not chosen so that TRANS runs out of data before the MASK

DATA file is filled. For example, when transforming a 20 minute square the user may locate the corner point anywhere in TAPE DATA as long as 20 minutes of data remain to the north and to the east of the location. This feature allows the user to position the MASK DATA file to best advantage in relation to terrain features or radar site locations.

In addition to transferring data based on a specified interval and origin, TRANS deletes all nonelevation information from TAPE DATA including labels, parity checks and the overlap values discussed before. The format of the data is also rearranged so that MASK can read MASK DATA as a FORTRAN matrix from right to left and top to bottom, equating this with west to east and north to south. A header is added in the first five data blocks of MASK DATA identifying the southwest corner of the file in degrees, minutes and seconds and listing the data interval specified during the transformation.

Transformation of data at latitudes greater than 50 degrees is handled within TRANS by a special algorithm. When a southwest corner latitude is greater than, or equal to, 50 degrees north or 51 degrees south a temporary file is created. TRANS then reads the TAPE DATA file and duplicates the records required to "pad" the data and make the file 1200 records wide. During this process, the padded information is stored in the temporary file. The file is then treated identically to a file from lower latitudes.

d. COMBIN

Thus far, MASK DATA has been limited to the size of one DTED file. While useful for fire control radars, the area of a single degree square is inadequate for evaluating the envelopes of longer range

acquisition and early warning radars. A program called COMBIN was written to increase the area coverage of the MASK DATA file. As previously stated, increasing the area of MASK DATA results in a commensurate degradation in resolution due to deletion of data points. In practice, this degradation has been slight but noticeable and is likely to be dependent on local terrain roughness and radar location as well as decreased resolution.

The concept of COMBIN is to create a mosaic of several files previously transformed by TRANS. Of neccessity, the output from COMBIN will still be limited to the size of the MASK DATA file and the caveat regarding resolution applies. To form the "tiles" of the mosaic, individual DTED files are transformed using intervals greater than nine and are stored in separate numbered files. When all of the required files are transformed and properly assigned by file definition (FILEDEF) to their positions in the mosaic, COMBIN systematically accesses the files by number and combines the data into the standard MASK DATA format. For example, if an area two degrees by two degrees were required, four separate DTED files would have to be processed by TRANS at an interval of 18. They would then be assigned by the user to FILEDEFs 11-14 according to their relative geographic positions with the northwest file assigned to 11, the northeast to 12, the southwest to 13 and the southeast to 14. COMBIN would then be run and would access each file in turn, placing the appropriate data in the mosaic. The product of COMBIN would be a MASK DATA file which would be identical to one produced directly by TRANS, except that it would cover four times the area at a reduced resolution. The same general procedure applies to larger areas.

At present, the largest area which COMBIN will process is a square mosaic of twenty-five individual DTED files. This equates to an area of about 200 by 300 nautical miles at 48 degrees of latitude. The five by five degree square was chosen as a limit for two reasons. First, the interval at this resolution is 45 arcseconds (three-fourths of a nautical mile) and that is a significant distance betwen elevation data points, especially in rough terrain. The second reason is that the process is largely manual, since the user must load and transform twenty-five DTED files and then assign each to a specific location in the mosaic. The next larger square would contain 36 files and that is considered excessively time consuming. An example using COMBIN will be presented in Chapter V.

3. Radar Parameters

a. Location

In addition to the data provided by the DTED, MASK prompts the user to provide specific information about the radar site or sites to be used. At a minimum, the latitude and longitude in degrees, minutes and seconds is required for each site. If no information about the radar site elevation is provided, MASK will determine elevation based on the location entered by the user. A separate entry must be made giving the antenna height above the ground. If this information is not known, a default entry will assign a value of five meters to the mast height. It is, of course, preferable to use the actual antenna elevation but MASK will perform the calculations using only the latitude and longitude if necessary.

Since site location is a critical variable in computing the masking envelope, an effort has been made to provide as accurate a site location as possible within the MASK DATA matrix. Some mention was made

in Chapter II of the requirement to cope with observers who fail to exist exactly at matrix element locations. This requirement is not as critical with a high resolution matrix as with one which has a large interval between data points. Positional errors in the large area data bases could be on the order of half a mile if site locations within the matrix were restricted solely to matrix element locations.

In general, geographic location in MASK is represented by the position of a subscripted element in the MASK DATA matrix. The point (1,1) defines the northwest corner of the matrix and (400,400) is the southeast corner. When MASK DATA is read by MASK the latitude and longitude of the southwest corner is used as the geographic reference point for the rest of the points in the matrix. By reading the transformation interval on the MASK DATA file header, MASK has all of the information necessary to compute the latitude and longitude of any element in the matrix. The actual location of any element in MASK DATA is completely determined by the data point location originally used in preparing the DTED file. These locations are used for the positions of the candidate points (CP) discussed in Chapter II. Location of the radar site is a more complex problem, since these sites will most likely be placed in locations which do not correspond exactly to the location of any DTED elevation data point. Note that in the following discussion (I,J) refers to the actual site locations, while (II,JJ) describes the closest MASK DATA element to the northwest of (I,J). A method was devised for MASK which allows for representing the exact site location in terms of a matrix element (II,JJ) and an incremental displacement (DI,DJ) from that element. This relationship is illustrated in Figure 3.4. Whenever MASK performs a measurement in relation to a site,

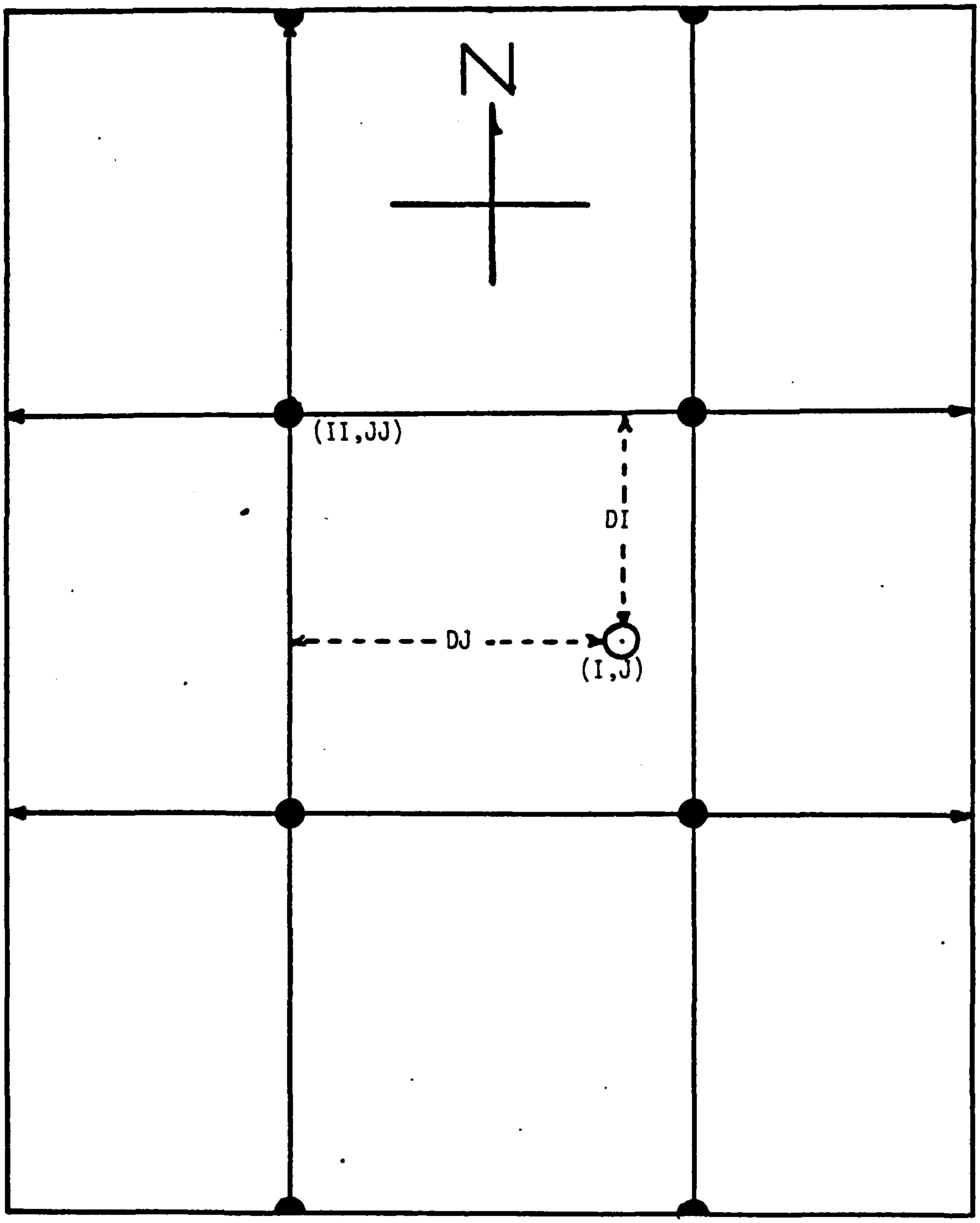


Figure 3.4 Radar Site Location Method

the distance is in terms of the distance to (II,JJ) and then an additional incremental distance is either added or subtracted to compensate for the offset location of the site.

b. Elevation

One of the applications of the method just described is in determining a given site elevation in the absence of specific user information. If the site were located exactly at a position corresponding to (II,JJ) it would only be necessary to dereference the value of (II,JJ) to obtain the site elevation. In most cases, however, an interpolation must be performed to derive an approximate elevation value. Since MASK keeps track of the exact position of the site within a four element square, a weighted interpolation is performed based on the relative proximity of the site to each of the four surrounding elevation data points. Consequently, the interpolated elevation value derived by MASK is more accurate than a simple average of the elevations of the surrounding points.

It should be noted that although the internal manipulation of data in MASK is in terms of meters, the input values are specified in terms of feet to comply with common usage in the Navy.

c. Pulse Repetition Frequency

The final site parameter is the pulse repetition frequency (PRF) of the radar. MASK accepts a value up to 9999 pulses per second. This is used to compute the radar's maximum unambiguous range (MUR) according to equation 3.2,

$$MUR = C/(2 \times PRF), \qquad \text{(eqn. 3.2)}$$

where C is the speed of light in a vacuum. If there is a range of PRF the user should enter the lowest value which is operationally employed.

Some radars use two simultaneous PRFs to extend the MUR. In this case, the user should enter the difference between the two. The MUR is used in MASK to reduce run time by limiting masking calculations to those points in the matrix whose slant range from the radar is less than the MUR. Points outside the MUR are automatically classified as masked. If the user does not desire the MUR limit imposed, a default value of -999 will set the PRF value so low that the MUR is beyond the display capabilities of MASK. In particular, deletion of the MUR limit would be applicable to all non-pulsed radars.

d. Multiple Sites

MASK is capable of processing and displaying the combined envelopes of up to nine different radar sites on any given run. After completing all required entries for sites one through eight, MASK will prompt the user to input additional sites as desired. If more sites are required, the user so indicates and then supplies inputs for the next site as previously discussed. After the ninth site has been entered MASK will not accept further site information.

4. <u>Refractive Effects</u>

One of the features of MASK is the modelling of the effects of refraction on radar and optical propagation paths. The concept outlined in Chapter II requires that an equivalent earth radius be calculated as a function of the refractive gradient, dn/dh. MASK uses the scaled-up gradient, dN/dh for this purpose. The value of dN/dh must be computed and input by the user if non-standard propagation is to be modelled. In the standard case, the user enters a value of -039 which results in the conventional four-thirds earth radius model. Land based systems

will not normally be subject to effects such as superrefraction or ducting, since these phenomena are caused primarily by the formation of evaporation layers over large bodies of water. If, however, a land based system is located in an essentially marine atmospheric environment significant anomalous propagation can result. An example of such a situation is the use of radar for coastal defense and surveillance. If the radar is placed sufficiently close to the coast it will be immersed in a marine air mass and is likely to be subject to the refractive anomalies normally associated with shipboard radar propagation. In these cases a non-standard value of dN/dh should be used to determine the equivalent earth radius.

The best available source of information on the value of dN/dh is the IREPS computer program, which is installed on all CVs. One of the outputs of IREPS is a table of N values for various heights in kilometers above MSL. In addition, IREPS predicts a radar ducting height if conditions would produce one. To compute dN/dh, the user chooses an altitude above MSL and subtracts the value of N at the radar antenna height from the value of N at the specified altitude (the result will normally be negative). This number is then divided by the difference between the two altitudes in kilometers. The altitude should be chosen to include the proposed strike altitude. For example, if the strike altitude were 5000 feet MSL the user would choose an N value at an altitude of about 1525 meters, interpolating as necessary from the available altitude readings. The value of dN/dh obtained in this manner would be the average gradient from the surface to 5000 feet MSL. If ducting is predicted by IREPS, this indicates that an average value is probably not appropriate, since there will be a significant difference in dN/dh values at various altitudes.

In these cases, the predicted ducting height should be used to calculate dN/dh. If the radar and the aircraft are both below the ducting height, MASK will use the non-standard value of dN/dh. Otherwise, standard four-thirds earth radius will be used. It is recommended that the value of dN/dh be computed whenever the information is available, since even normal refractive conditions cover a wide range of values for dN/dh.

MASK does not model atmospheric effects at the same level of sophistication as the IREPS program. Consequently, there is one case in which MASK will not produce accurate results. This occurs when ducting is present and the radar is located inside the duct but the aircraft is located above the duct. MASK contains no algorithm to predict the radar's ability to "see through" the top of the duct. In this case, MASK uses the four-thirds earth radius model and produces coverage envelopes which are likely to extend well beyond the radar's actual coverage. The terminal prompt message for entering ducting height contains a specific warning to this effect. In such situations the user should consult the IREPS vertical coverage diagram for the radar in question to determine the severity of predicted radar coverage loss.

One special use of the refractive effects inputs is to model the coverage of optical systems. Under standard conditions the distance to the optical horizon is approximately seven percent greater than the geometric horizon and seven percent less than the radar horizon [Ref. 4: p 48]. The reason that the optical horizon is less than the radar horizon is that light refraction depends only on temperature and pressure and not on humidity as in the case of radar. The result is that the values of dN/dh obtained from IREPS cannot be used to account for optical

refraction. It is possible, however, to model standard day optical refraction in MASK by entering a dN/dh of -020, which equates to the correct equivalent earth radius for optics. This value has no relation to the actual optical refractivity but is merely a means of tricking MASK into producing standard day optical conditions. The appropriate ducting height value in this special case is 99999.

5. Strike Altitudes

MASK is able to process two types of strike profiles simultaneously. The first type is a cruising profile in which the aircraft maintain a given altitude above MSL. This profile is applicable to transiting to and from a low altitude descent point or for strike elements whose mission requires that they remain at higher altitudes. The second type is a terrain following profile which is applicable to strike aircraft attempting to remain below the terrain masking altitude during the terminal portion of the attack. MASK requires that the user enter a value in terms of feet above ground level (AGL) and one in terms of feet above MSL. There is no requirement for any dependence between the two values, thus allowing for simultaneous processing of coverage envelopes for widely separated strike elements. A special value is required by MASK if the user does not want one or the other of the coverage displays to be output.

6. Topographic Display Selection

The user must choose whether or not to display a topographic map of the area covered by MASK DATA. It is necessary to have a copy of the topographic display in order to interpret the masking envelope displays. However, the topographic display will not change unless MASK DATA is changed, so one initial copy will suffice for any number of envelope displays as long as the same MASK DATA file is used.

7. Input Errors

If, at any time during the input phase, an entry is made in error it cannot be changed. The only corrective action is to press the ENTER key twice which causes the program to abort. All previous inputs are automatically erased and the program must be run again from the beginning.

Since the inputs for MASK are all integers, it is vital that the user enter them in the correct format using right justification. Each prompt message specifies the exact format of the required response, including sign if negative values are appropriate. The only exception is a value of zero, in which case the format is irrelevant. Failure to comply with the specified input format will produce results ranging from inaccuracy to program abort.

C. MATHEMATIC MODEL

1. General

This section discusses the mathematic model which manipulates the input data and creates the output displays. The model is composed of the main program, MASK, five subroutines and three short functions. All program elements are written in FORTRAN IV and use the IBM 3033 FORTHX compiler. Calculations are primarily done in single precision with the exception of some of the angle computations which use double precision. In addition to the MASK program elements, there is an executive program called FLY EXEC which defines certain files and compiles, loads and runs either MASK, TRANS or COMBIN. Other functions related to acquiring temporary disk space and moving files from MVS to disk are performed by a profile executive program during the log-on procedure. In the sections which follow, each of the program elements is discussed, emphasizing the

the concepts used to solve the masking calculation problem. Detailed discussion of the program code is only used when required to explain the method used by a particular routine.

The main program is presented first from start to finish, followed by each subroutine in order and then the functions. Flow charts are interspersed in the text to provide a graphic display of the program structure. It will be helpful for the reader to briefly review the flow-charts prior to reading the explanations in the text. The flowchart for the main program, MASK, is shown in Figure 3.5.

2. MASK

The first portion of MASK is devoted to reading the input data discussed in the previous section. At the end of this phase MASK knows the position and elevation of each element in MASK DATA, the southwest corner of MASK DATA, the transformation interval, the latitude, longitude, elevation, mast height and PRF of each site, the number of total sites, strike altitudes in AGL and/or MSL terms, dN/dh, ducting height and topographic display selection.

The next operation is initialization of variables. These include actual earth radius, resolution of the output displays, the value of pi, the relation between meters and feet and the dimensions of the output displays. At this time the AGL and MSL output displays are intialized to the masked condition.

If the user has requested a topographic display, the LOOK subroutine is called and generates the display which is stored in the output file. This operation is essentially "off line" and does not require any core storage in MASK.

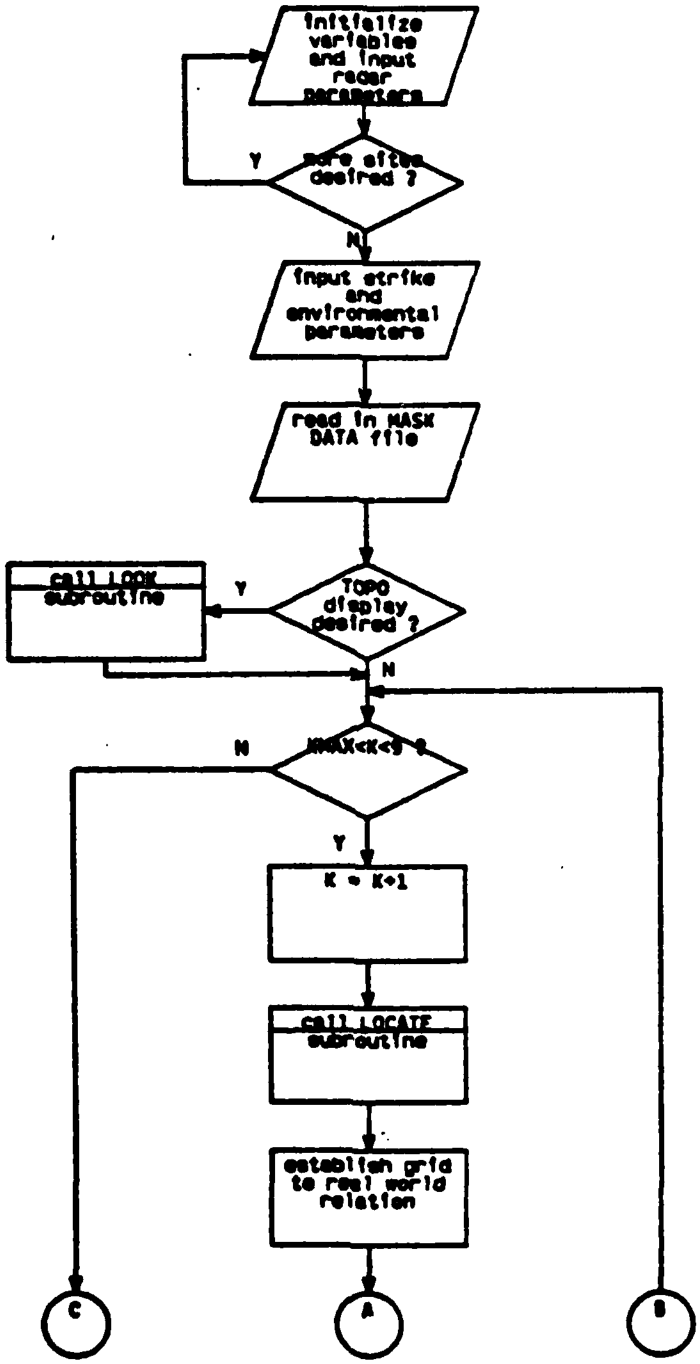


Figure 3.5a Flow Chart for MASK

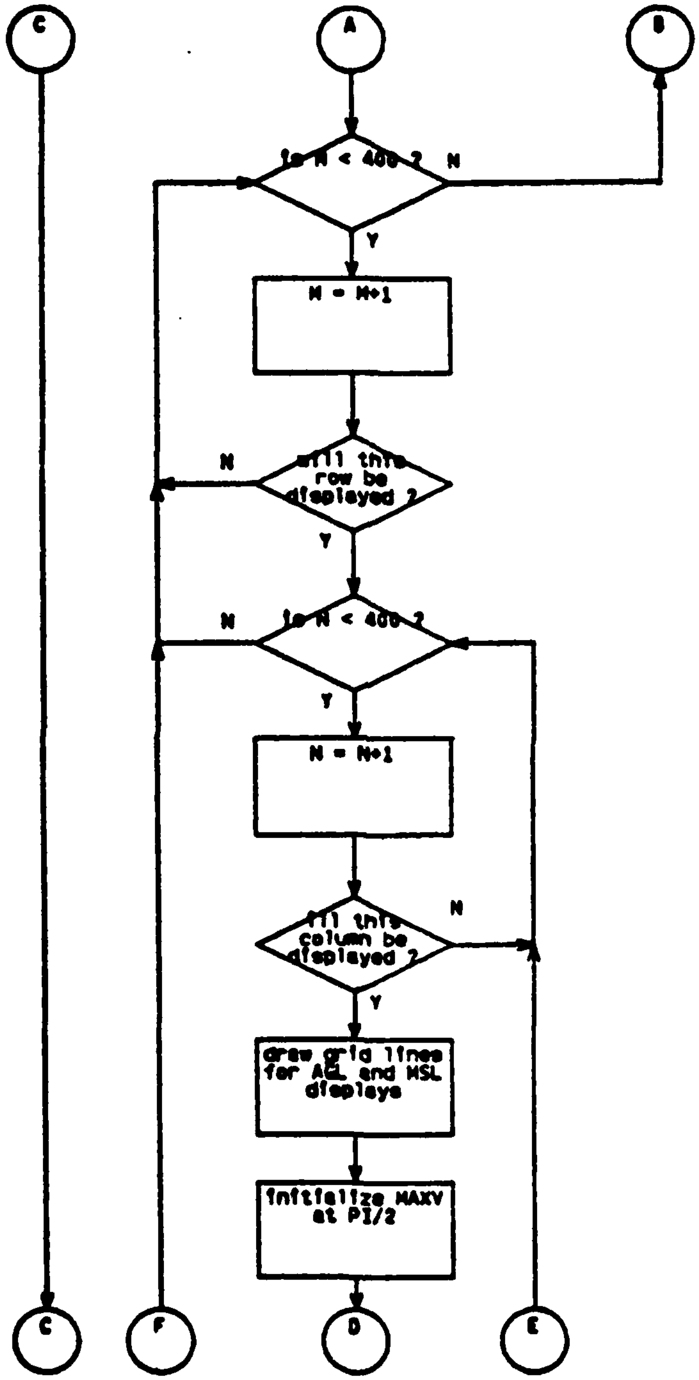


Figure 3.5b Flow Chart for MASK

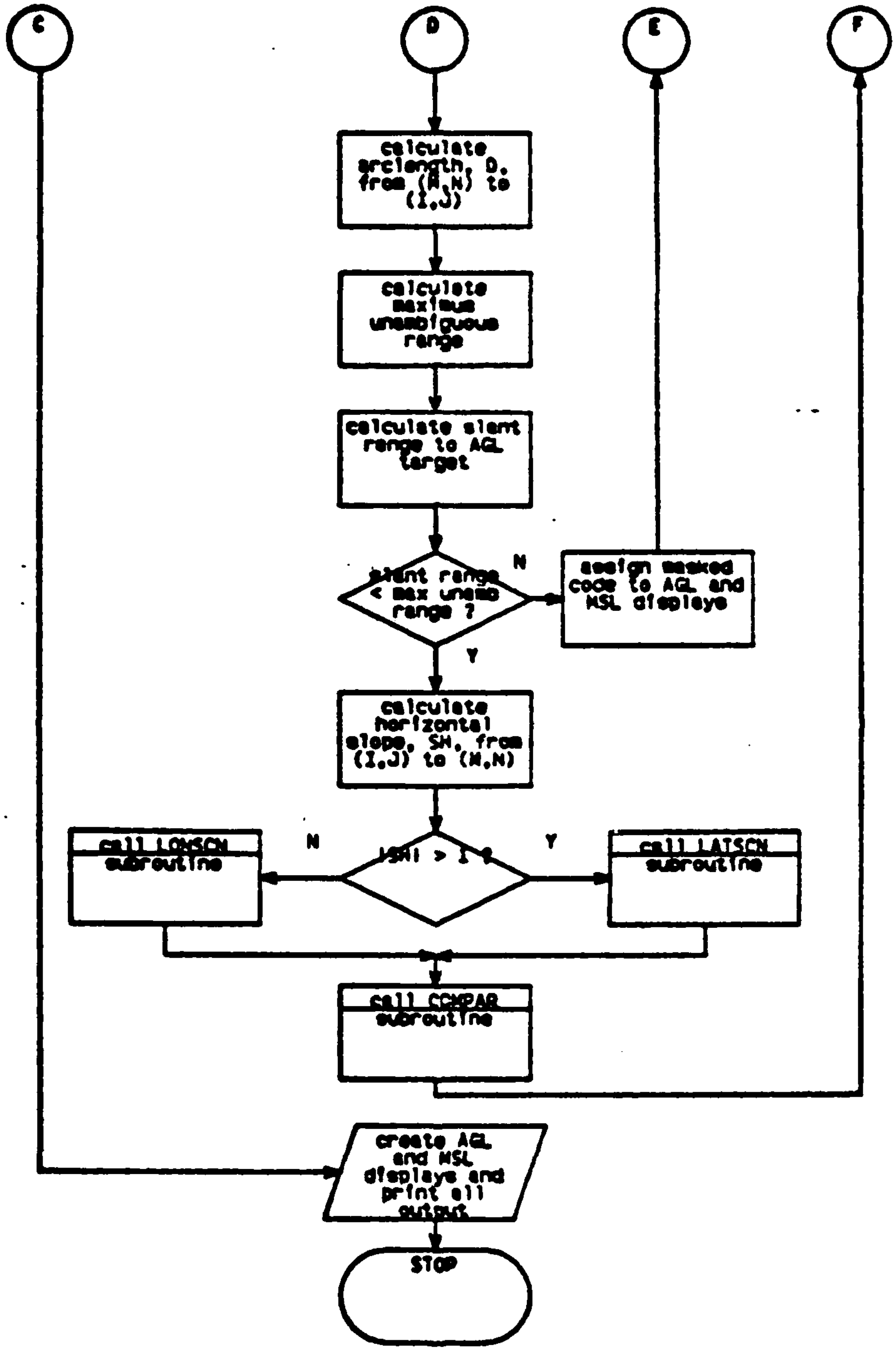


Figure 3.5c Flow Chart for MASK

The next operation is to initiate the loop which calls up each radar site in sequence. The description which follows applies to all sites as they are processed.

The first step is to compute the radar maximum unambiguous range which is stored for later comparison with the slant range from the site to each CP. Next, the LOCATE subroutine is called and returns the position (I,J) of the site and the antenna mast height if the default value is used. MASK then takes the integer value (II,JJ) of the site and subtracts (II,JJ) from (I,J) to obtain DI and DJ. These two variables describe the site offset from (II,JJ) to the south and east, respectively. If site elevation has not been explicitly input, MASK then performs the previously described interpolation of site elevation. Mast height is then added to the elevation to obtain the antenna height above MSL.

The calculations performed so far have all been in terms of matrix position or elevation. In order to measure horizontal distances along the ground a relationship must be established between the matrix dimensions and real world. As previously mentioned, the distance between elevation data points decreases as latitude increases according to the cosine of the latitude of the positions in use. In this case the latitude value used is that of the radar site. The number of meters between points in latitude (MPPLAT) is computed based on the number of meters per arcsecond of latitude (approximately 30.87) and the number of arcseconds of interval used between points. For example, if an interval of three were used MPPLAT would be approximately 92.6. The number of meters per point in longitude (MPPLON) is obtained by multiplying MPPLAT by the cosine of the radar site latitude. MPPLAT and MPPLON define the north-south and

east-west dimensions, respectively, of an imaginary rectangle formed by any four adjacent elements of MASK DATA. Another way to visualize this relationship is to think of MPPLAT as the ground distance between any two matrix elements (M,N) and (M+1,N) and MPPLON as the distance between (M,N) and (M,N+1). All horizontal distance measurements in MASK are in terms of these two basic values.

The next event is the initiation of the nested loops which scan MASK DATA from west to east and north to south. The outer loop is the north to south one and uses the index variable, M, while the inner loop uses N as an index variable and scans from west to east. These two loops scan the entire MASK DATA matrix, but only a fraction of the elements (M,N) are actually processed as CPs. The reason is that although MASK DATA is a 400 by 400 matrix, the output matrices are only 80 characters square and will therefore only display one element in five horizontally and one in five vertically. There is no sense in processing elements which will not be displayed, so only one in twenty-five elements (M,N) is chosen as a CP. The twenty-five to one ratio is solely a function of the output display size relative to the size of MASK DATA; use of larger output displays would increase the number of CPs processed. It should be emphasized that although only a fraction of the MASK DATA elements are used as CPs, none of the matrix elements are excluded from the terrain masking calculations since the computations performed at each CP use every MASK DATA element between the CP and the site.

The first event within the (M,N) loops is to establish the five to one ratio of M and N to the display matrix indices, DM and DN. In contrast to the elements (M,N), every element (DM,DN) will be used as a CP and will be displayed during output.

At this point the display matrices are accessed and a grid network is superimposed so that the matrices have horizontal and vertical lines printed on all four borders and at the points corresponding to DM or DN equal to 20, 40, and 60. This grid is identical on all output matrices and is used as an aid in correlating the information contained in the various displays.

The first displayable element (M,N) is now dereferenced and its value becomes the height above MSL of the first CP. The value of MAXV is initialized at its minimum value of -pi/2 to begin the loop. The maximum unambiguous range (MUR) is compared with the slant range between the site and the CP. If the slant range is greater than the MUR the CP is considered masked. If not, the horizontal slope (SH) is computed according to equation 3.3.

$$SH = (M-I)/(J-N) \qquad \text{(eqn. 3.3)}$$

If J is exactly equal to N (both have the same longitude) SH is set to an arbitrarily large positive value.

The next section of MASK is devoted to sampling all intermediate points (X,Y) between (I,J) and (M,N) as described in Chapter II. The sampling value used depends on the value of SH. Logically speaking, MASK can be divided into four quadrants defined by two perpendicular lines intersecting at (I,J) with slopes of one and negative one. All those CPs which fall into the upper and lower quadrants have an SH whose absolute value is greater than one. The CPs in the left and right quadrants have slopes whose absolute value is less than or equal to one. If the MASK DATA matrix is envisioned as a network of horizontal and

vertical lines whose intersections define the individual element locations, the horizontal lines can be thought of as lines of equal latitude and the veritcal ones as lines of equal longitude. If a CP is in an upper or lower quadrant, a line connecting it to the site will intersect more latitude lines than longitude lines. The opposite holds if the CP is in a left or right quadrant. All sampling for the CPs in the upper and lower quadrants is done at the points (X,Y) where the line from (I,J) to (M,N) intersects one of the horizontal lines. Conversely, the (X,Y) points for CPs in the left and right quadrants are located at the intersections of the vertical lines and the line from (I,J) to (M,N). This method is illustrated in Figure 3.6.

Two separate subroutines handle the sampling in MASK. The LATSCN subroutine is used for CPs in the upper or lower quadrants and LONSCN is used if the CP is in the left or right. Both routines perform the necessary calculations outlined in Chapter II in order to determine a value for MAXV at each CP and return the value to MASK.

The last subroutine called by MASK is COMPAR. It is given MAXV and other inputs which it uses to compute the masking altitude, MHM, above (M,N). The output from COMPAR is a variable for each CP, indicating whether or not a target is masked at the specified strike altitude above the CP. As each CP is processed the indicator variables are stored in the output matrices for later display as discussed in section E.

3. LOOK

The LOOK subroutine provides a topographic display of the contents of MASK DATA. This display is the key to interpreting the AGL and MSL displays. An alphabetic code is used to denote the elevation of each

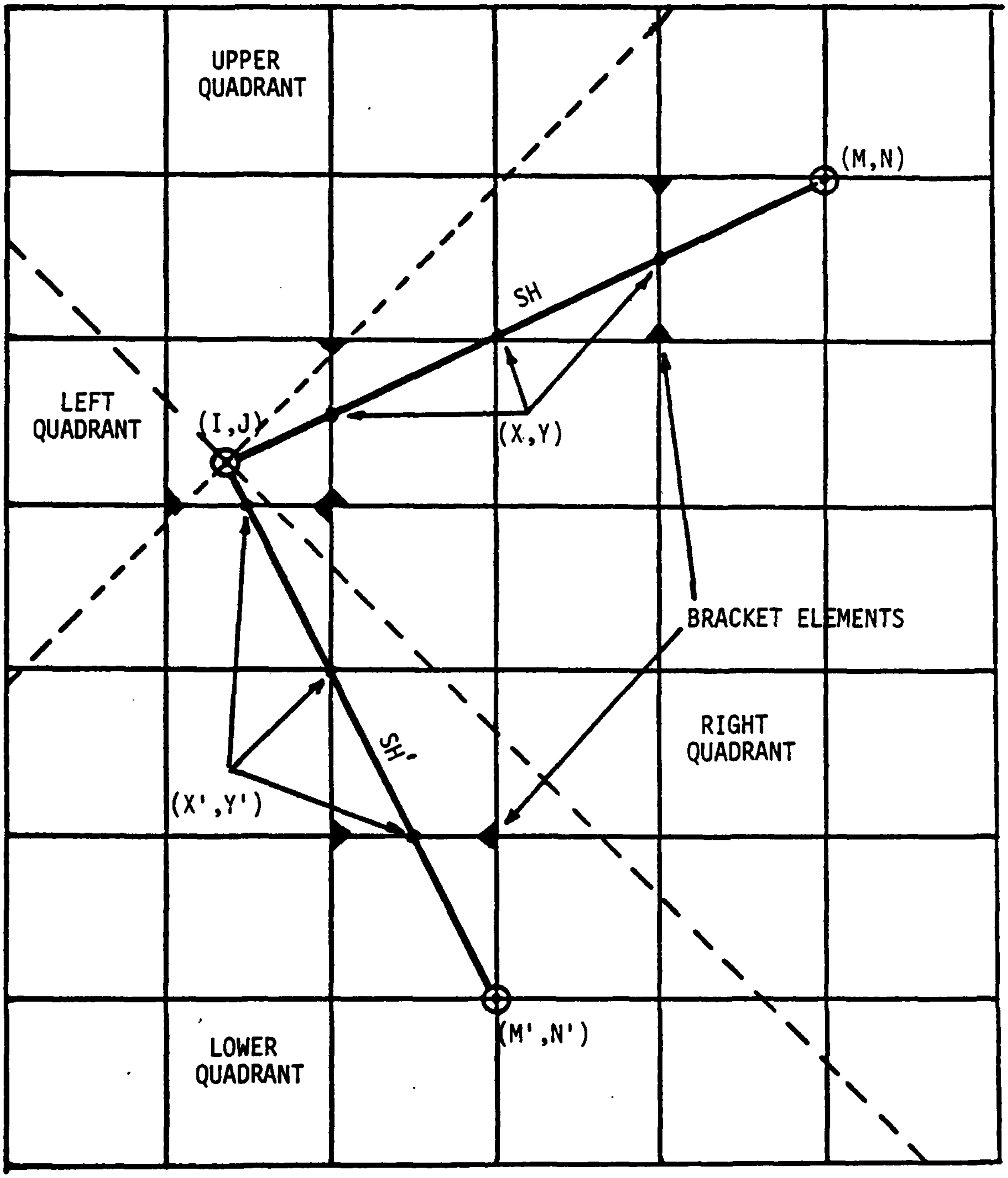


Figure 3.6 Sampling Technique for Various Quadrants

element. By comparing adjacent codes, LOOK "blanks out" all codes which are not part of a boundary between one elevation value and the next higher value. The result is that only boundary elements are displayed and these form contour lines of equal elevation. Grid lines identical to those on the AGL and MSL displays are superimposed on the LOOK output matrix to aid in display correlation. The output is annotated with the latitude and longitude of the southwest corner of MASK DATA and with a legend providing the relation between the alphabetic codes and the corresponding elevation bands. The flowchart for LOOK is shown in Figure 3.7.

4. LOCATE

LOCATE determines the location of a given radar site in terms of a matrix position (I,J) within MASK DATA. It modifies its calculations to account for latitudes above or below the equator and west or east of 0 degrees longitude. Site position is based on the latitude and longitude relative to the southwest corner of MASK DATA and is transformed into matrix position by use of the transformation interval value. In addition, it assigns a default mast height value of five meters if no specific value is provided by the user. The flowchart for LOCATE is shown in Figure 3.8.

5. LONSCN

LONSCN performs the task of sampling intermediate points (X,Y) between (M,N) and (I,J) when the CP is in the left or right quadrant relative to (I,J). At each (X,Y) point LONSCN locates the two elements of MASK DATA which bracket (X,Y) directly to the north and south. The location of these elements is determined by the slope of the line, SH, and the distance from Y to J. The elevation values of the bracketing elements are used to interpolate the elevation value of (X,Y). The interpolation is

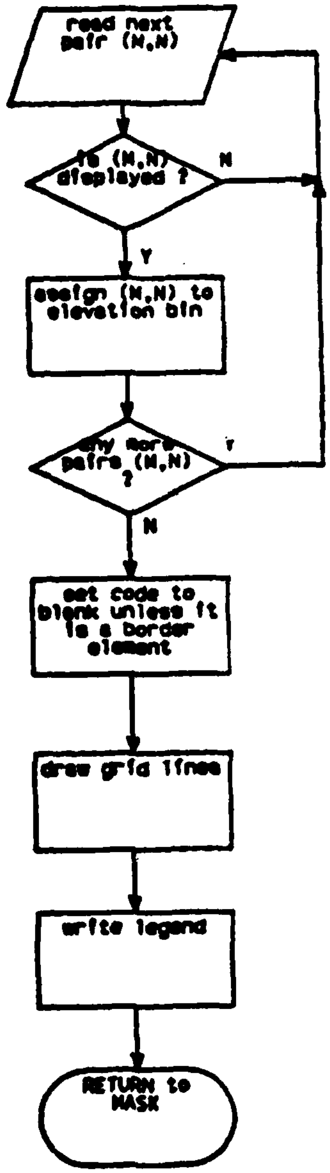


Figure 3.7 Flow Chart for LOOK

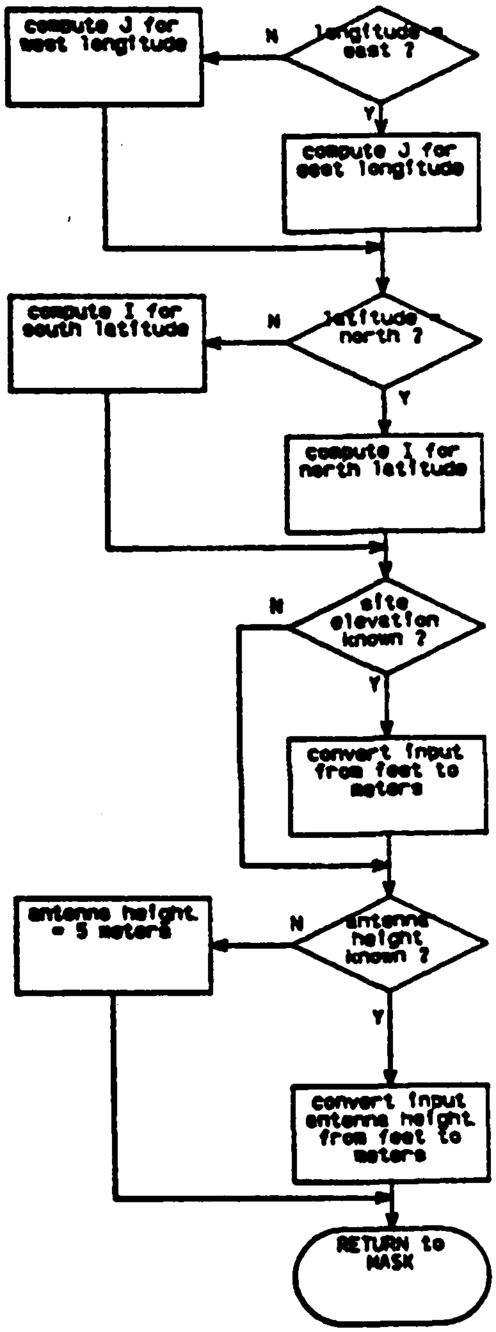


Figure 3.8 Flow Chart for LOCATE

done using a weighted value for each elevation based on the distance of (X,Y) from each element. If (X,Y) chances to fall exactly on a MASK DATA element the elevation of that element is simply assigned to (X,Y).

LONSCN also performs the spherical to planar transformation discussed in Chapter II. The first step in this process is to find the ground distance from (I,J) to (X,Y). This is done by first computing the length of the hypotenuse of a triangle whose base is equal to MPPLON and whose height is equal to SH times MPPLAT. This distance corresponds to the length of a segment of the line from (I,J) to (M,N) as it passes between two vertical lines separted by one N-unit. This length is then multiplied by the difference between Y and J to give the desired ground distance. The ground distance is divided by twice the equivalent earth radius to give the value for the angle, ALPHA. ALPHA is then used to compute the equivalent heights, h1' and h2', and the increased distance D'. SV' is computed as discussed in Chapter II and is compared with the current value of MAXV. If SV' is larger than MAXV, MAXV takes on the value of SV' for the next comparison. The next adjacent (X,Y) point is then investigated using the same process. Once all (X,Y) points along the line have been investigated the existing value of MAXV is returned to MASK for use in COMPAR. The flowchart for LONSCN is shown in Figure 3.9.

6. <u>LATSCN</u>

LATSCN performs the same operations as LONSCN for all CPs in the upper or lower quadrants. The code is, of course, written to handle the problem with a 90 degree rotation of axes, but the concepts are identical. The flowchart for LATSCN is shown in Figure 3.10.

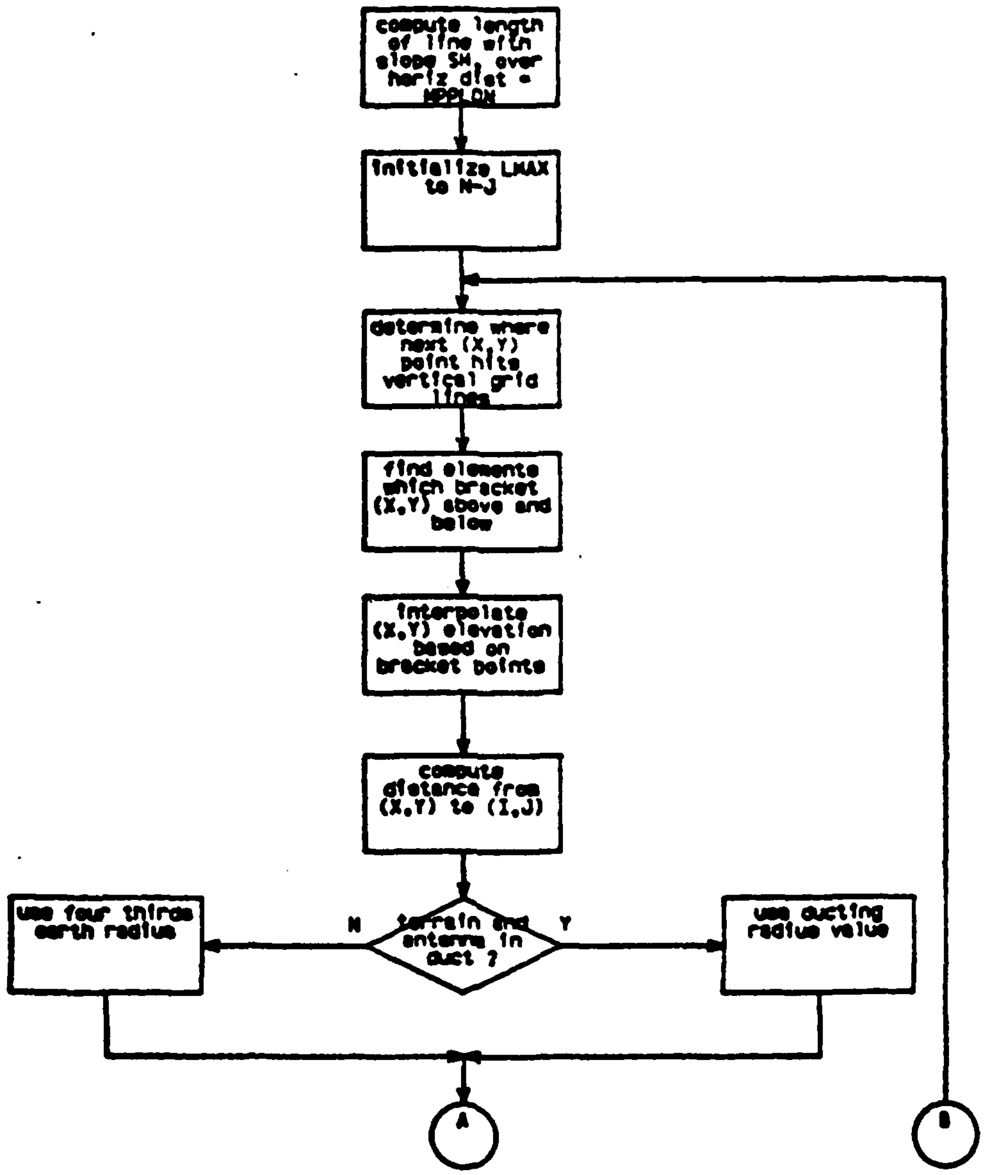


Figure 3.9a Flow Chart for LONSCN

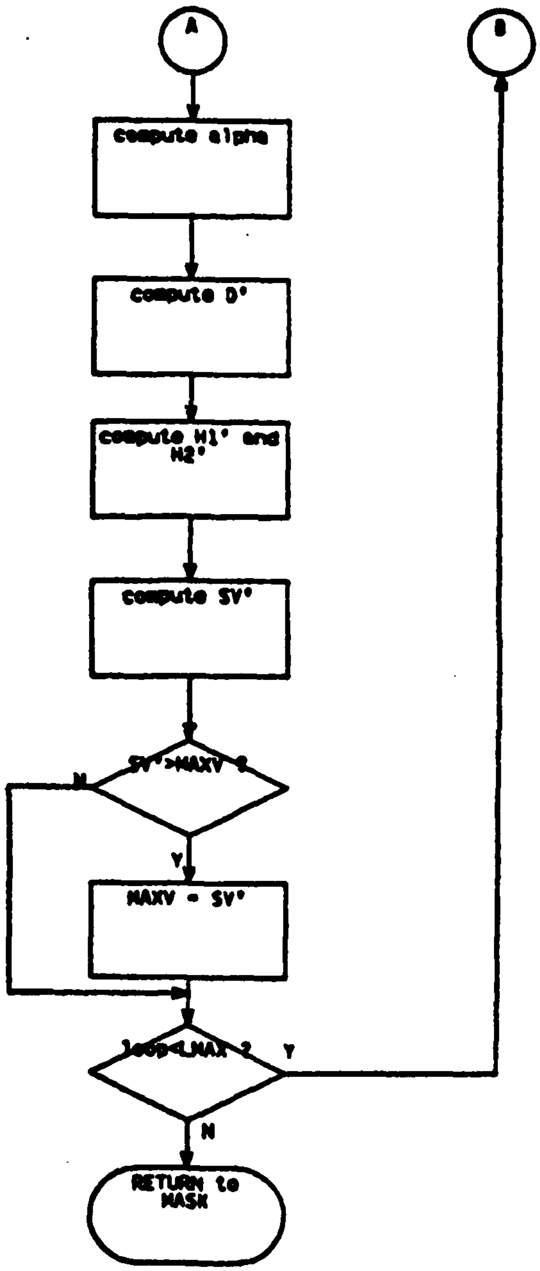


Figure 3.9b Flow Chart for LONSCN

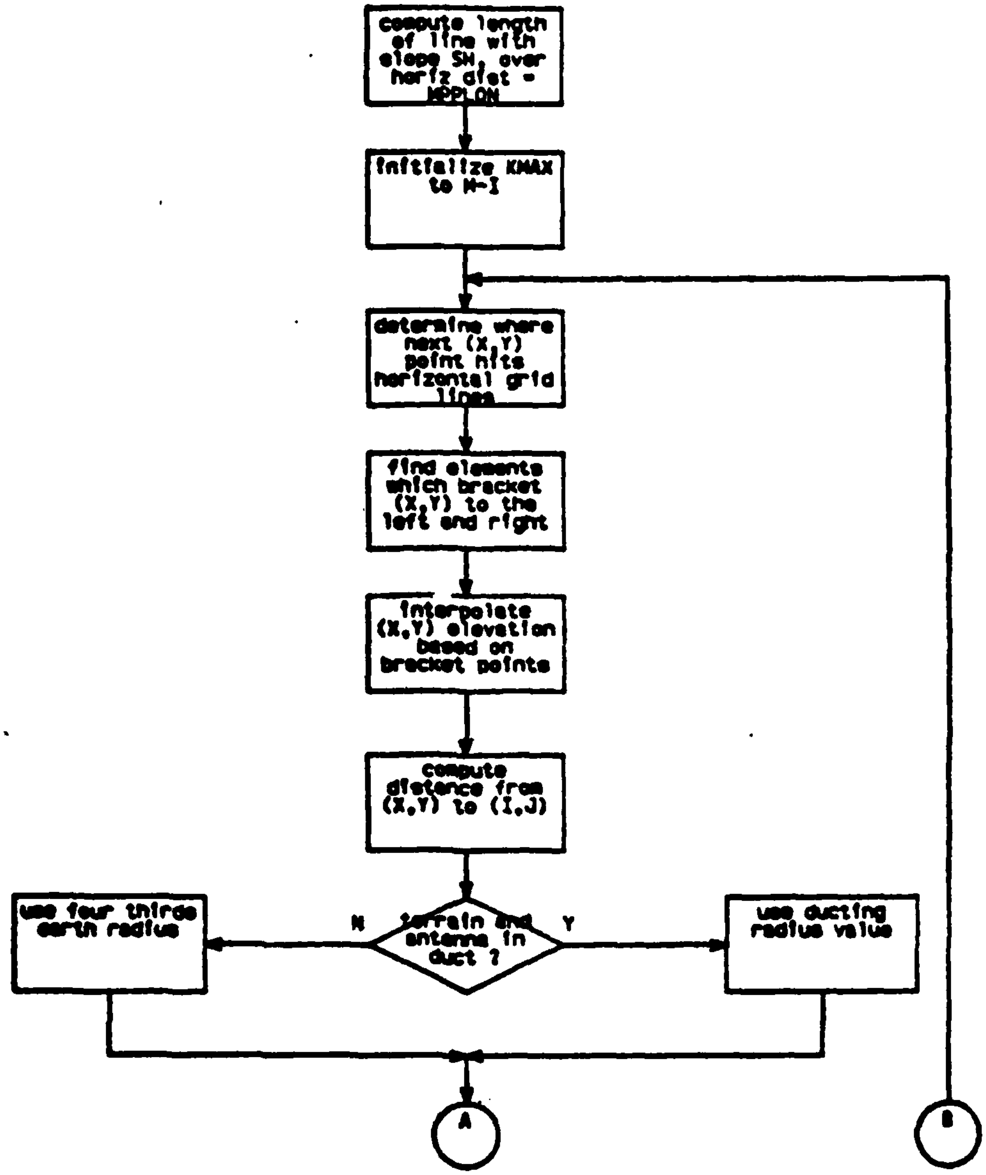


Figure 3.10a Flow Chart for LATSCN

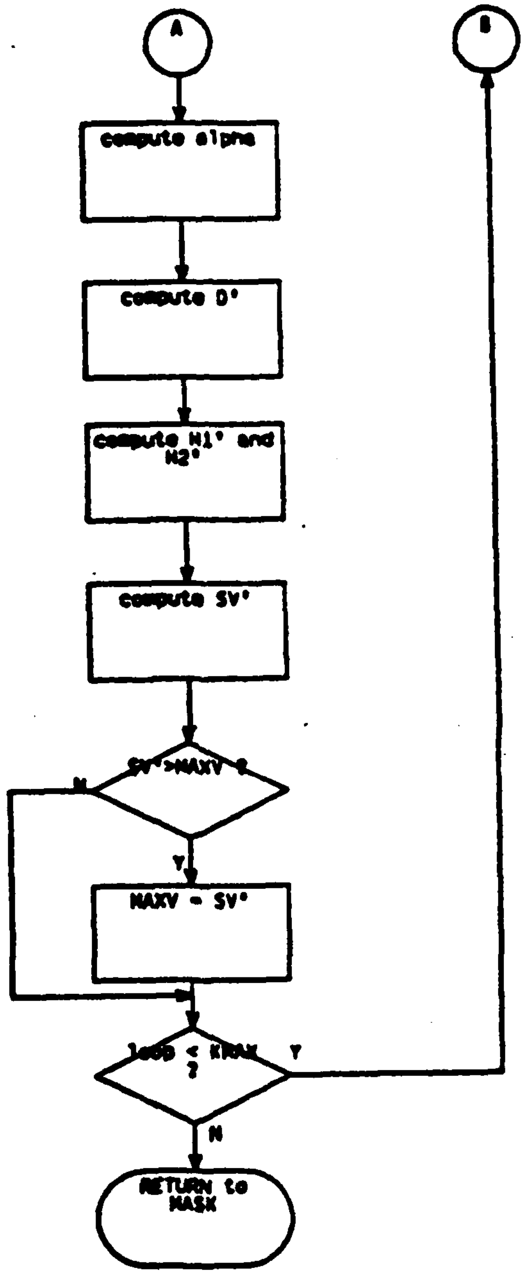


Figure 3.10b Flow Chart for LATSCN

7. COMPAR

COMPAR performs several functions. The first is the calculation of the masking height in meters above MSL at the CP. The problem is set up as a triangle having one apex at the radar antenna (A), one at the center of the equivalent earth (C) and one at an unknown height (B) above (M,N). The distance from (I,J) to (M,N) is the arclength separating AC and BC at the equivalent earth radius from C. The angle (BETA) subtended by this arclength is obtained by dividing the arclength by the radius. The angle between AB and BC is pi minus the sum of MAXV and BETA and is the angle opposite to AC. The length of the side AC is known to be the equivalent radius plus antenna height above MSL. By using the above information and the Law of Sines, COMPAR obtains the length of the side BC. The value of the masking height above MSL (MHM) is obtained by subtracting the equivalent earth radius from the length of BC. A corresponding value for the masking height above ground level (MHA) is obtained by subtracting the elevation value at (M,N) from MHM.

The determination of the state of the indicator variable at (M,N) is made by comparing MHM to the input MSL strike altitude and MHA to the AGL altitude. If MHM is greater than the MSL strike altitude, the indicator variable takes on a value equivalent to a masked condition. If MHM is less than the MSL altitude, the indicator variable shows that the aircraft is unmasked and within the radar maximum unambiguous range at the specified altitude. The MHA comparison performs the same function in relation to the AGL strike altitude. The MHM comparison may also result in a third state for the indicator variable. This occurs if the specified input value of the MSL strike altitude is less than or equal to the terrain

elevation at the CP, regardless of the masking calculation. This state is displayed to alert the user to the fact that the assigned MSL altitude is infeasible at that particular point. The indicator variables generated by the calculations for the point (M,N) are stored in the AGL and MSL displays at the location (DM,DN), which is identical in both displays.

As the MASK DATA matrix is sequentially investigated, the indicator variables in the AGL and MSL matrices eventually form sets of masked points, unmasked points and, in the MSL matrix, points where terrain elevation exceeds strike altitude. A procedure is employed, similar to that used in LOOK, which blanks out all masked and unmasked indicator variables except those which define the boundary between the two sets. The result is an envelope extending out from the radar site within which an aircraft at the specified altitude is in the direct line of sight and inside maximum unambiguous range. COMPAR also generates up to nine numbered site locations for display in the AGL and MSL outputs. If more than one site is placed at the same display element only the number of the last site input will be displayed on output. If envelopes from multiple sites overlap, the individual boundaries within the overlap area are deleted and the envelopes are merged into a single continuous area of coverage. This results in a much more easily interpreted output display. If individual envelopes are desired, the user must run the sites separately. The flowchart for COMPAR is shown in Figure 3.11.

D. FUNCTIONS

MASK uses three short functions. The IASEC function converts degrees, minutes and seconds of arc into units of seconds only. The RAD function

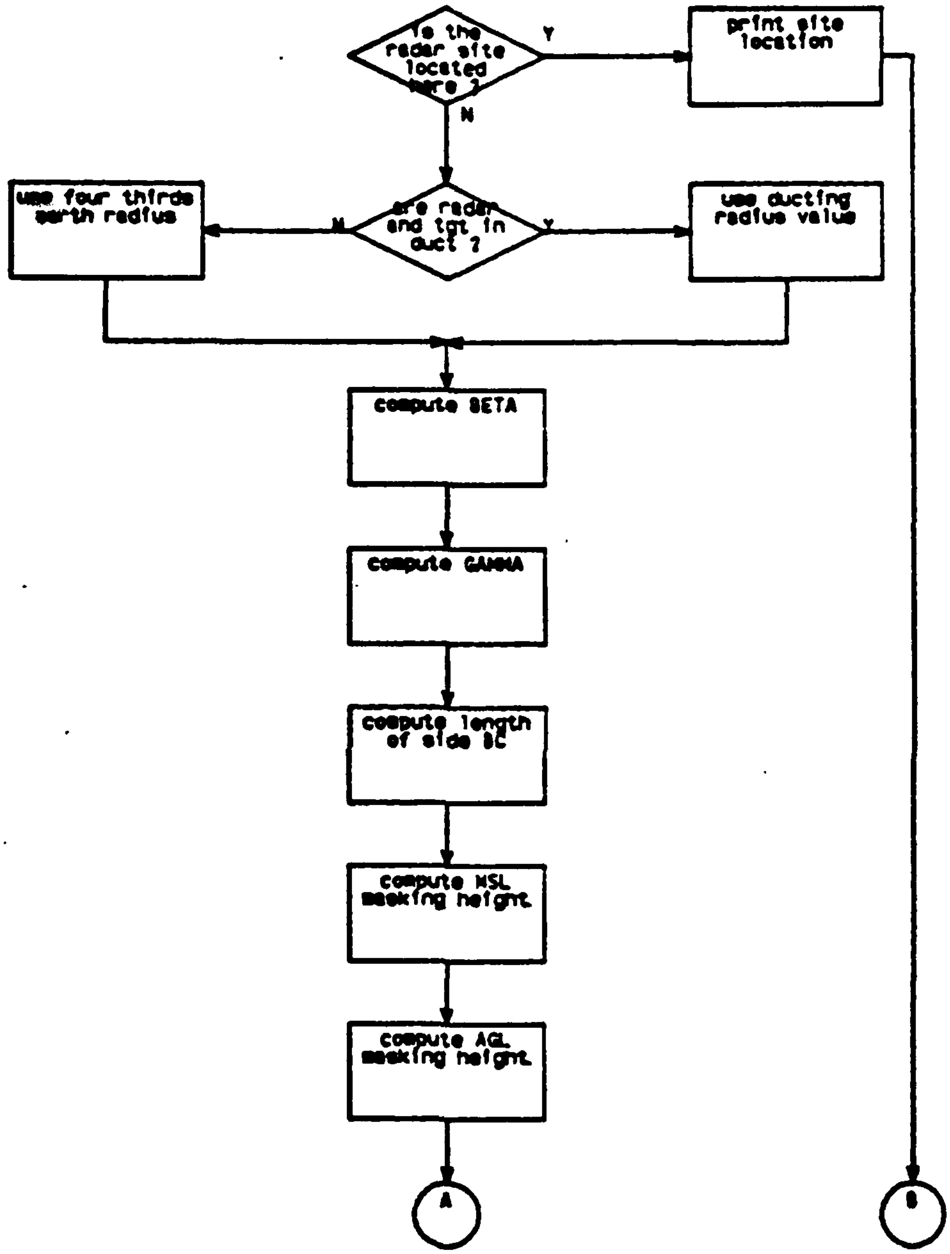


Figure 3.11a Flow Chart for COMPAR

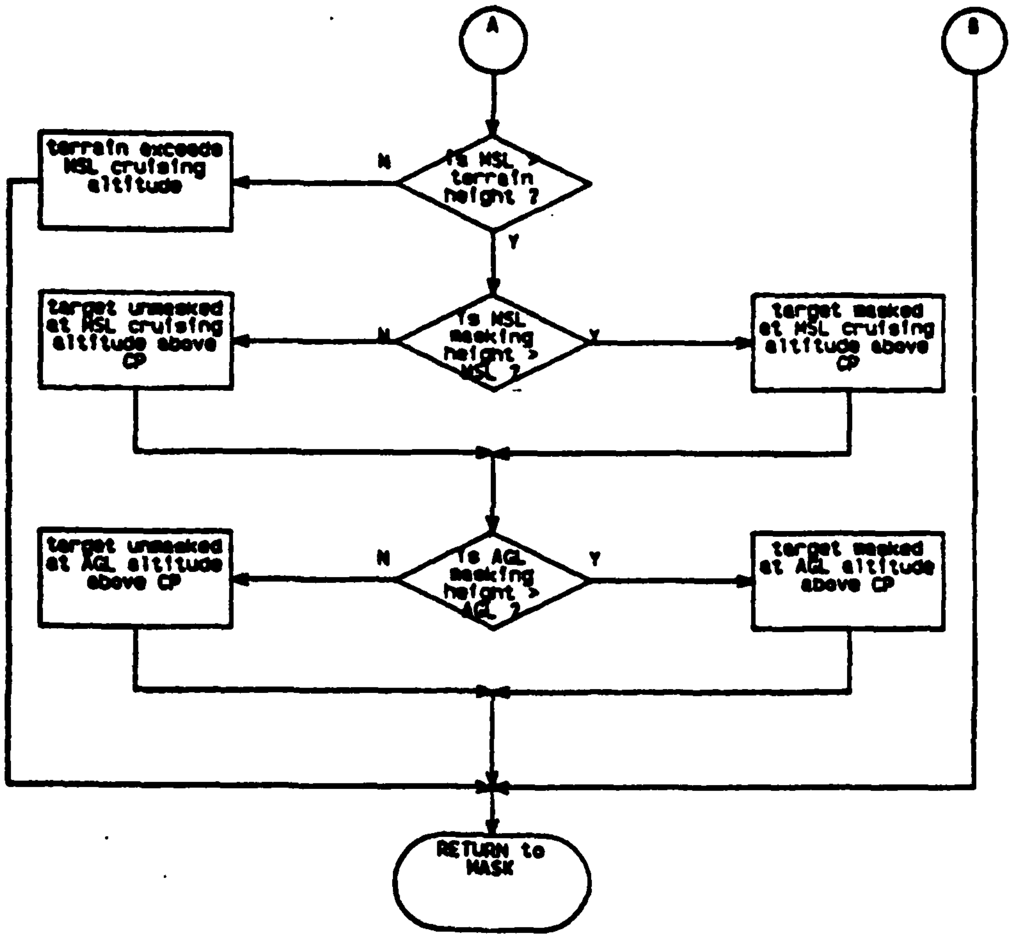


Figure 3.11b Flow Chart for COMPAR

converts degree angular measurements into equivalent radian values. IRND converts real numbers to integers by performing a round-off (instead of the normal truncation used by the library function).

E. OUTPUT

1. Topographic Display

The topographic display is selected by the user during the input phase. The purpose of the display is to provide a reference to aid in relating the AGL and MSL masking displays to actual geographic features such as mountain ranges, river valleys and coastlines. The topographic display has much the same appearance as a typical topographic chart. Contour lines are spaced closely in areas of steep terrain and are more widely spaced in areas of moderate terrain variation. Coastlines are easily recognized due to the use of the special symbol (.) for sea level elevation. The grid system which overlays the elevation code provides additional cues for locating geographic features and relating them to the same features on standard aeronautical charts. In effect, the topographic display acts as the interface between the AGL and MSL masking displays, which contain almost no geographic references, and the detailed charts used in planning strike routes. Figure 3.12 shows a typical topographic display while Figure 3.13 shows the same geographic area on an aeronautical chart.

2. AGL Display

The AGL display shows numbered site locations and the masking envelope for the specified AGL strike altitude. The area depicted in the display is identical to the area covered by the topographic display.

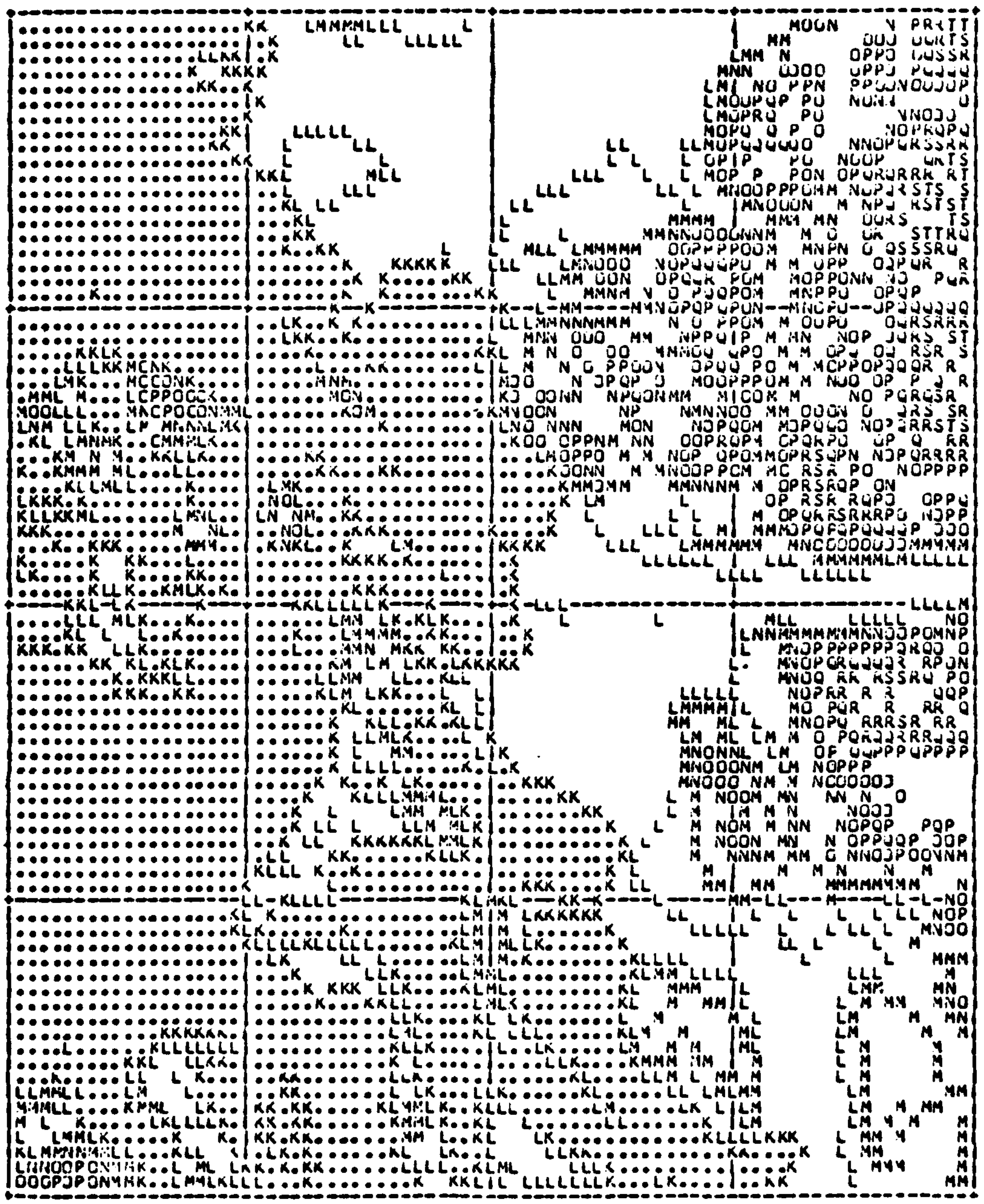


Figure 3.12 Topographic Display Example

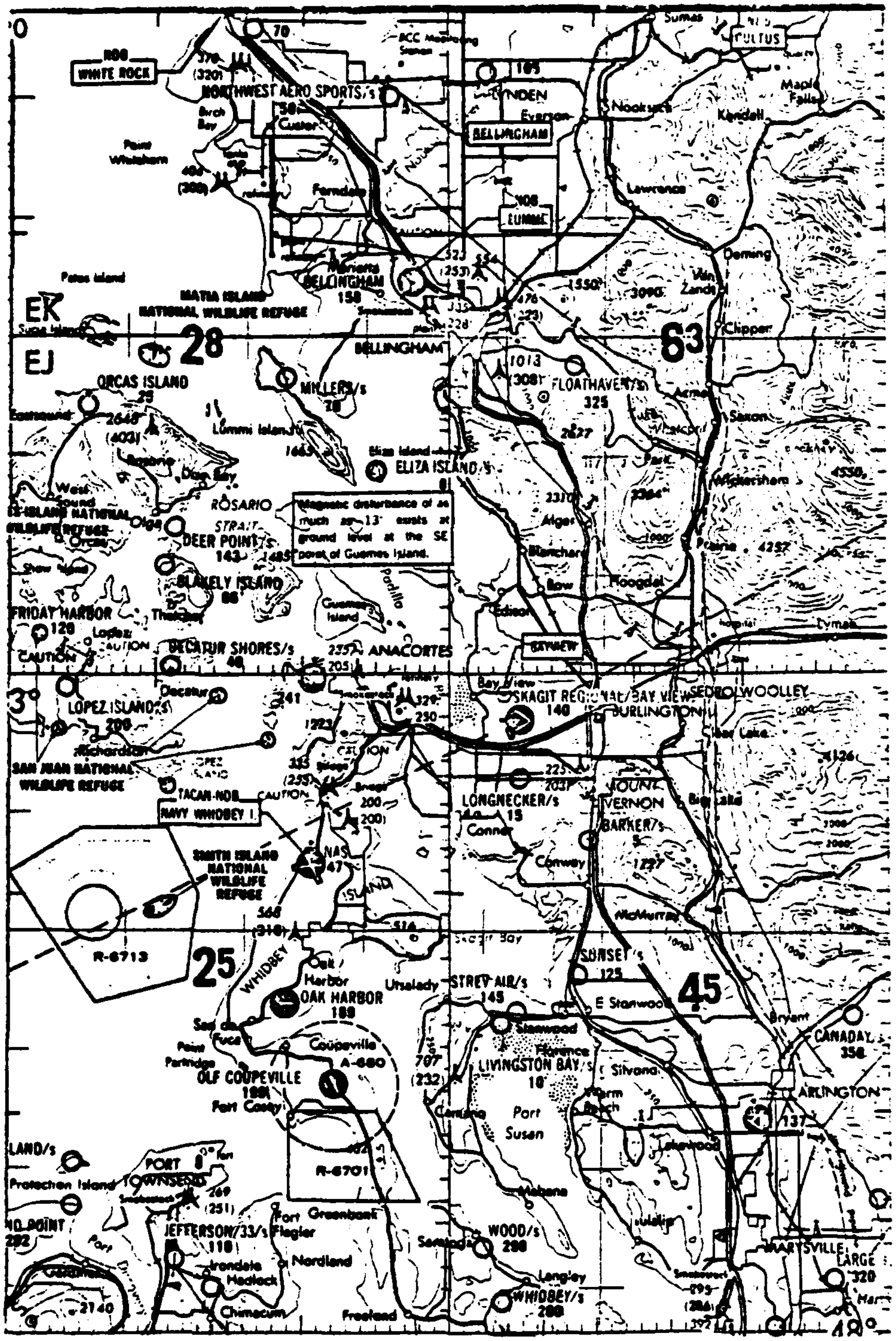


Figure 3.13 Aeronautical Chart Corresponding to Topo Display

There is, in fact, a one to one relationship between each position on the topographic display and the corresponding position on both the AGL and MSL displays. This allows the user to physically overlay one display on top of another during the correlation process. The recommended procedure is to highlight the masking envelope with a dark pen, place the topographic display on top of the AGL display and simply trace the envelope onto the topographic display. If desired, transparencies may be made of the AGL display and then used as overlays on top of the topographic display.

In addition to the graphic portion of the AGL display there is a separate printed page containing amplifying information. The information includes the latitude and longitude of the southwest corner of the display, the grid spacing in minutes, the physical dimensions represented by each display symbol, dN/dh, ducting height, the input parameters of each radar site and a legend describing the meaning of the display symbols.

One common effect shown in the AGL displays warrants some explanation. Instead of a single envelope being displayed, it is not unusual for the AGL display to contain several disjoint masking enveolopes. The explanation for this is that the aircraft altitude is varying with ground elevation in order to maintain a constant AGL height. As a result, the specified AGL altitude will occasionally rise above the masking height and then fall below it closer to the site. This would occur, for example, if the aircraft had to climb over a ridge at some distance from the site. Just prior to cresting the ridge the aircraft would enter the unmasked envelope and then as the aircraft descended into the valley below it

would become masked again until it came sufficiently close to the site to be seen continuously. In this manner, several disjoint areas of clear line-of-sight are normally generated in mountainous areas, while fewer are generated in less variable terrain. This situation does not occur at all over water, nor does this effect appear in the MSL displays, since the aircraft are maintaining a constant MSL altitude.

3. MSL Display

The MSL display contains the same information as the AGL display except that the indicator variables are generated by comparing the masking height with the specified MSL strike altitude at each CP. The symbology, grid markings and explanatory pages are identical to those used in the AGL display with one addition. The symbol "0" is used to denote areas in which the terrain exceeds the specified MSL altitude. Flight in such regions is infeasible for obvious reasons.

IV. MODEL VERIFICATION

A. GENERAL

This chapter will briefly describe methods of verifying the accuracy of the output from MASK.

The most realistic and most costly method of verifying the results of MASK's calculations is flight testing using actual radars and aircraft. There are, however, other methods which may be used to ascertain whether or not MASK is performing properly. Two such tests are presented below. Prior to describing the tests, however, some explanation should be given regarding the data base used in the tests.

B. TEST DATA BASE

In order to have a simple data base of known characteristics a test data base was developed for MASK. The data base is a 400 by 400 element matrix containing three pyramids which are placed on a sea level plain. Figure 4.1 is a topographic display showing the arrangement of the pyramids. The pyramids are of varying heights with the one in the southeast area of the plain being the shortest. The northwestern pyramid is twice the height of the short one and the northeastern one is four times the height of the short one. The two to one ratio of heights between successively taller pyramids facilitates certain comparisons which are used in testing.

Some characteristics of the test data base are designed to be adjustable by changing the appropriate parameters in the program, TERR, which creates the data base. The transformation interval may be varied from 3 to 45 arcseconds, effectively changing the area coverage of the data base

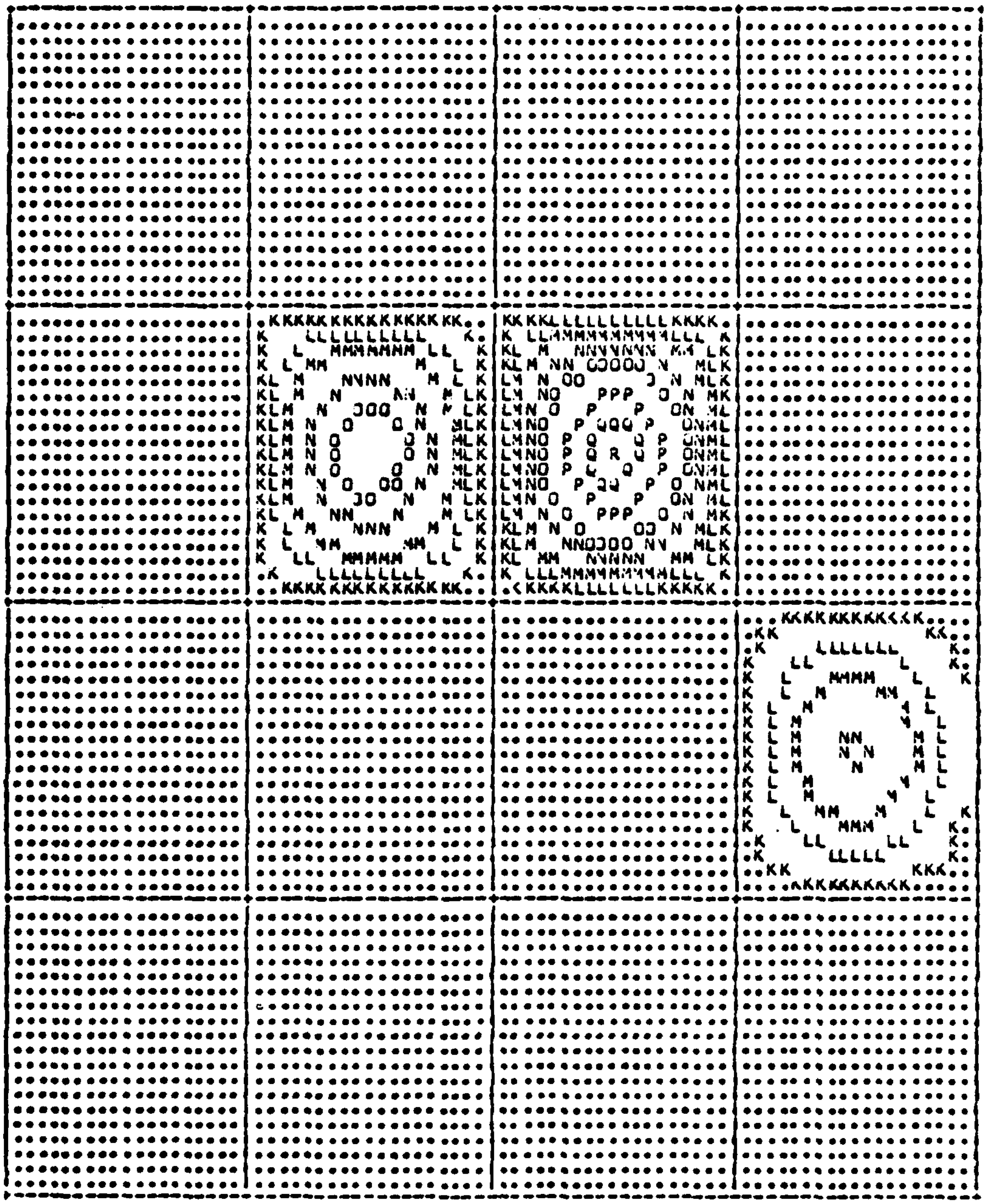


Figure 4.1 Test Data Base Configuration

and increasing distances between elevation data points. The latitude and longitude may be changed to represent changing ratios of MPPLON and MPPLAT in different latitudes. The heights of the three pyramids may be varied from zero to an arbitrarily large value as long as the ratio of heights remains as previously described. This last change is accomplished by changing the value of a height multiplier which is applied to all elements in the matrix. As originally designed, the pyramids had heights of 25, 50 and 100 meters. By using a multiplier value of ten the heights were increased to 250, 500 and 1000 meters while the sea level plane, of course, remained constant. In this manner it is possible to alter the data base to represent a level plain or ocean surface, an area of moderate terrain variation or one in which there are radical elevation changes. The obvious advantage of using this type of data base for verification is that it is a test pattern which may be easily modified by the user to suit a particular scenario.

The FLY EXEC is used to define the necessary files and execute TERR. It should be noted that FLY defines output files on a temporary "D" disk, so the user should acquire temporary storage prior to executing TERR. Once the D disk has been defined, the user need only type "FLY TERR" and press the ENTER key to execute the program. The resulting output file is a MASK DATA file identical in format to one produced by TRANS or COMBIN.

C. RADAR HORIZON TEST

The radar horizon test checks the ability of MASK to accurately predict the radar horizon on a smooth earth surface. This test was chosen because there is an established method, independent of any calculations used in

MASK, of determining the radar horizon for a smooth earth. Use of the smooth earth removes terrain features from the process, but does not diminish the validity of the test, since the curvature of the earth's surface serves as a replacement for terrain features. In fact, the angular and height measurements required to predict the radar horizon on a smooth earth involve the discrimination of values which are very close to one another and pose an added challenge to the model.

The independent method of predicting the radar horizon, HR, uses equation 4.1,

$$HR = SQRT\ (2 \times KA \times h), \qquad \text{(eqn. 4.1)}$$

where KA is the equivalent earth radius and h is the height of the antenna. For the test, KA will be assumed to be four-thirds earth radius. The test data base is set at an interval of 6 arcseconds at latitude 46 and the height multiplier is set to zero, producing a sea level plain 40 nautical miles by approximately 27.8 nautical miles.

For the test, MASK uses three sites with varying antenna heights. To facilitate measurement of the distances to each MASK horizon, the sites are located in the corners of the data base. The southeast site has a 200 foot antenna, the northeast has a 100 foot antenna and the southwest has a 50 foot antenna. The gradient is set to -039 and zero ducting height to simulate the four-thirds earth radius used in equation 4.1. Since the target is a point on the ground, the strike altitude used by MASK is zero feet AGL and the MSL output is blanked.

If MASK performs correctly, the results should conform to those obtained by using equation 4.1. For antenna heights of 200, 100 and 50 feet and KA

equal to four-thirds earth radius the resulting radar horizons are, respectively, 17.4, 12.3 and 8.7 nautical miles from the sites. As an aid in distance measurement it should be noted that the grid marks on the MASK output in this case are spaced ten nautical miles apart in latitude and approximately seven miles apart in longitude, with each display element occupying an area approximately .5 by .35 nautical miles. A brief inspection of Figure 4.2 shows clearly that the output conforms to the predictions obtained using equation 4.1.

D. TERRAIN MASKING TEST

The second verification procedure makes use of the fact that the tallest pyramid is exactly twice the height of the next shorter one. In order to perform this test the data base must be made to behave like a flat earth. This allows the use of some simple geometric relations to test MASK's calculations. Creation of this situation only requires that a value of -156 be used for the value of dN/dh. This produces a terrain model whose radius of curvature is about 160 times that of the earth, effectively flattening the data base.

The test data base has a transformation interval of 9 arcseconds and a southwest corner location of 46 degrees north and 123 degrees west. This produces a data base 60 by approximately 42 nautical miles with grid markings spaced every 15 minutes of arc. The pyramid height multiplier is equal to ten, giving the northwest pyramid a height of 500 meters (1640 feet) and the northeast a height of 1000 meters (3280 feet).

The test scenario is depicted in Figure 4.3. The site is located to the north of the two tallest pyramids. The distance from the site to a point on the plane directly beneath each peak is defined as B and is the

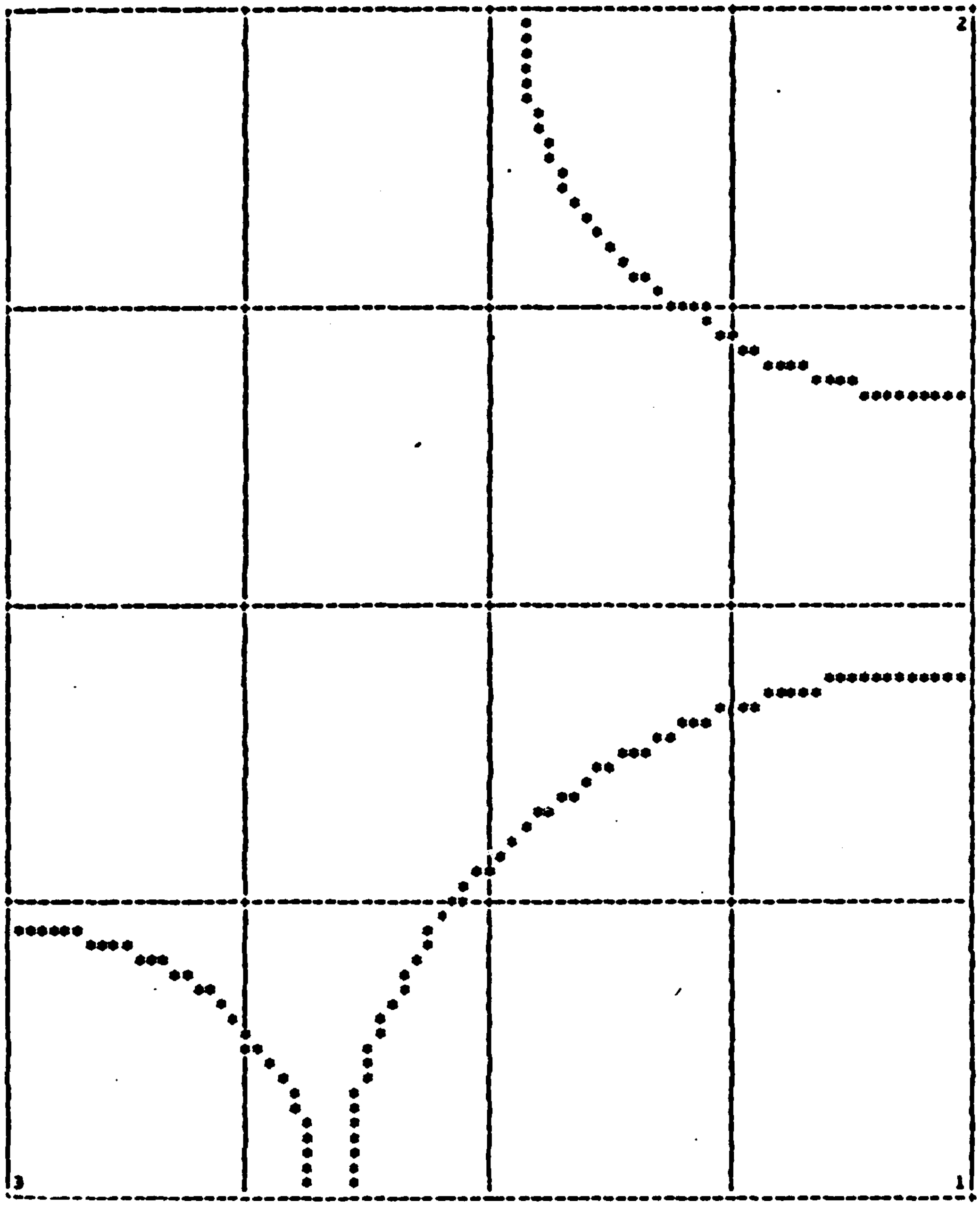


Figure 4.2 Radar Horizon Test Results

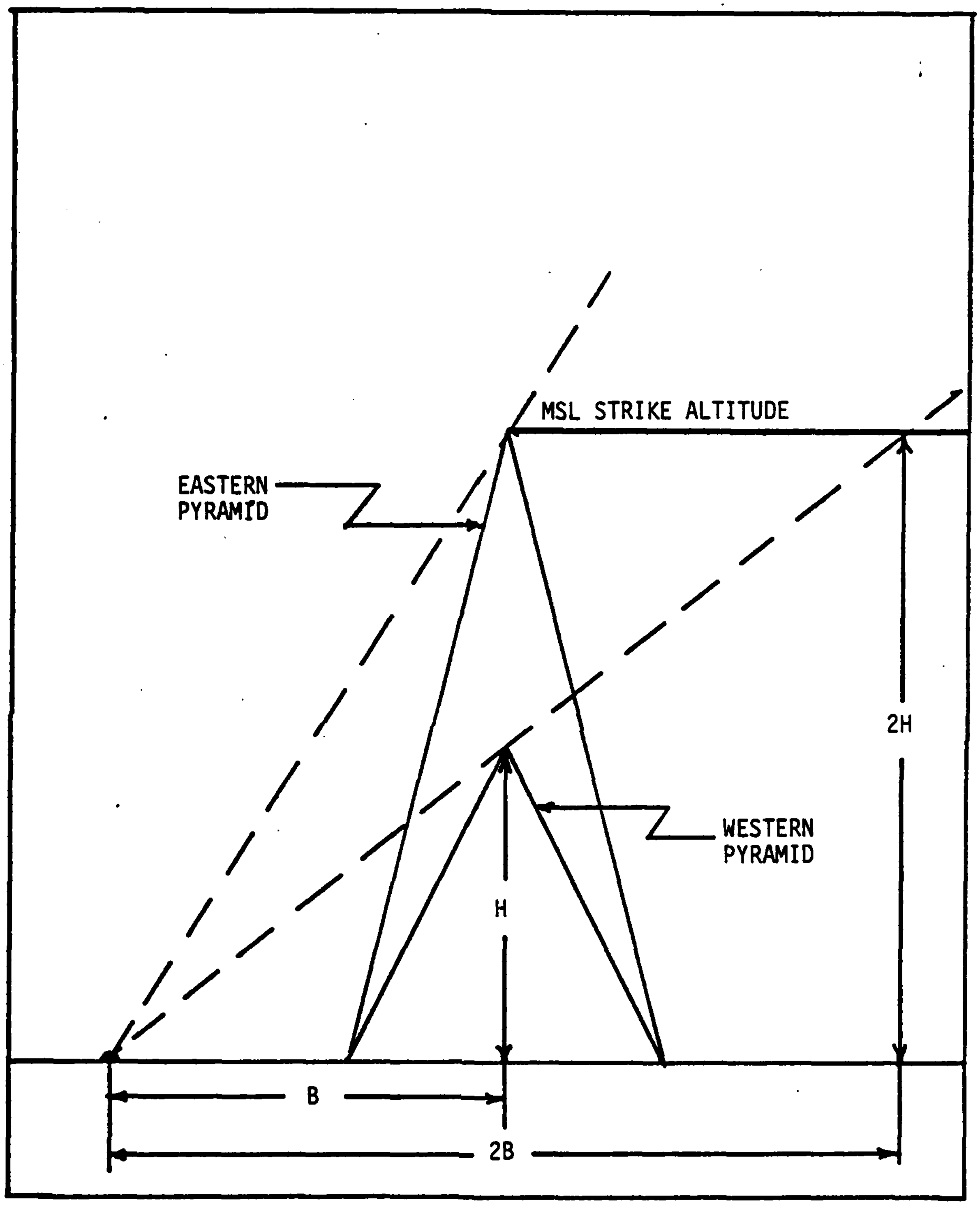


Figure 4.3 Terrain Masking Test Scenario

same for both pyramids. The height of the shorter pyramid is H, and the height of the taller one is 2H. The altitude of the target aircraft is also 2H, so that there is no separation between the target and the taller peak when the aircraft passes over it. Each pyramid is illuminated by the site and casts a V-shaped radar shadow at the given MSL altitude of 2H. In the case of the taller pyramid, the apex of the shadow is located exactly at the peak and the ground distance from site to apex equals B. In the case of the shorter pyramid, the apex of its shadow meets the MSL altitude at a greater distance south of the peak. By using similar triangles it can be seen that since the height of the shorter pyramid is H, the distance required for the shadow to reach a height of 2H is exactly 2B, or twice the distance encountered in the case of the tallest pyramid. If MASK performs correctly, this relationship should be duplicated on the MSL display.

For this test MASK uses a site location of 46 degrees, 55 minutes north and 122 degrees, 30 minutes west, which equates to midway between the two northern peaks and 17.5 minutes north of a line connecting the two. The site elevation is set to zero, dN/dh is -156, ducting height is 99999 and the strike altitude is set at 3280 feet MSL (2H). The AGL display is not needed. The output from this run is shown in Figure 4.4. The MSL display is annotated to show the locations of the two northern peaks and the lines from the radar site to the apex of each shadow. Note that the apexes do, in fact, lie on the lines extending from the site through the peaks of the pyramids. In addition, the apex of the eastern shadow is located at the position of the eastern peak, as desired. The apex of the western shadow is located at a distance away from the site equal to twice

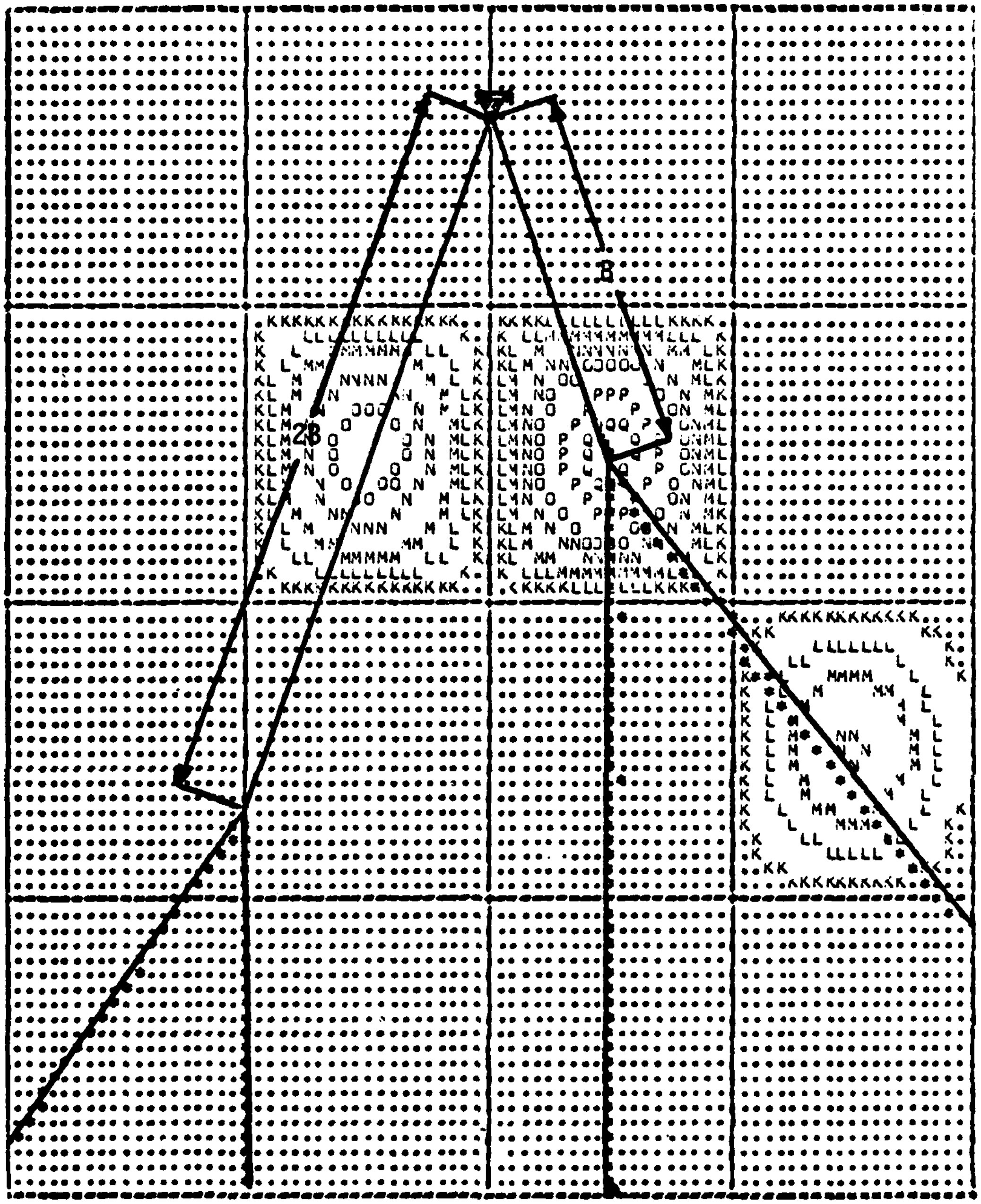


Figure 4.4 Terrain Masking Test Result

the distance from the site to the eastern apex. Clearly, the situation predicted by the test scenario is duplicated by the MASK output.

Other verification methods are, no doubt, possible. However, these two tests are sufficient to show that MASK does accurately perform its calculations using the test pattern as a data base.

V. EXAMPLE PROGRAM PROCEDURES

A. GENERAL

This chapter presents examples of the procedures required to execute a MASK program. The sequence runs from accessing the DTED tape, through the transformation and combining steps and finally to the execution of MASK. In addition, a section is devoted to interpreting the MASK output. Following the procedural review, several examples of MASK output are shown to illustrate the effects of varying MASK input parameters. All computer programs referred to in this section are contained in Appendix A. All procedures refer to executing the various programs using the IBM 3033 system at the Naval Postgraduate School. Single quotation marks are used to denote that the text within the quotes is to be entered as an input value or used as a name.

B. SCENARIO

This example of MASK supports a hypothetical air strike against the Deception Pass highway bridge which links Whidbey Island in Puget Sound to the mainland. The bridge is located at latitude 0482400 north, longitude 1223900 west. The bridge is defended by a surface-to-air missile system located at latitude 0482000 north, longitude 1223900 west. The radar has two PRF's which do not operate simultaneously, but are used for different ranges to targets. The long range PRF is 1250 pulses per second. The exact site elevation is unknown and the mast height is estimated to be 20 feet. In addition to the SAM radar, there is an early warning (EW) radar near Bellingham, at latitude 0484800 north, longitude

1223200 west. It has a 100 foot mast height and a PRF of 400. The IREPS computer predicts a value of dN/dh equal to -050, indicating no ducting but slightly greater than normal refraction.

The strike leader has proposed that the attacking aircraft take off from their base at Tumwater, rendezvous at 7000 feet with chaff, jamming and anti-radiation strike elements and proceed north to bomb the bridge. Prior to reaching the immediate target area the bombers are to descend to 200 feet above ground level while the other strike elements maintain 7000 feet MSL, in order to decoy the defenses and launch anti-radiation missiles. The route of flight must allow the low altitude bombers to get as close to the bridge as possible while avoiding radar detection. The strike leader needs to know how soon his bombers must descend, how close they can get to the bridge without being detected and where the other elements must be positioned to be most effective.

The planning procedure for MASK is to examine the target area at high resolution and then expand the area coverage as required to encompass the early warning radar to the north and the rendezvous point located near Tumwater at latitude 0470500 north, longitude 1225500 west. This requires the sequential use of a 20 by 20 minute square data base centered on the SAM site, a 40 by 40 minute data base covering both radar sites, a one degree square data base with a southwest corner point at 48 north, 123 west and a two by two degree data base running from 47 to 49 north and 122 to 124 west. In practice, all of these data bases would probably not be required, but this example accounts for most of the operations that a user is likely to perform.

C. TAPE DATA TRANSFER

By refering to Figure 3.3, the user finds that the tapes required are S-798 and S-796, which cover the latitude bands from 47 to 49 degrees north. The data files required are file numbers 2 and 5 on each tape. The file containing the data at the target is in S-796, number 5 and is the first file to be transferred. The other three files will only be needed for the largest of the data bases.

1. PROFILE Exec

The PROFILE exec performs three operations which are required in preparation for the transfer of tape data. It defines a file called DSN S1086 DATA which is used to transfer the tape data into MVS on a temporary C disk and another file called TAPE DATA D1 which stores the data on the user's temporary D disk as it is transferred from MVS to the user. A final operation is the definition of the temporary D disk which has 20 cylinders of capacity and can hold three full DTED data files. Two final operations are required to be performed by the user. The first is to link to MVS by entering 'LINK MVS 1E3 291 RR' and the second is to access 291 as the C disk by entering 'ACC 291 C'. After the tape transfer is complete the user should release the C disk by entering 'REL 291 (DET'.

2. GETTAPE

The actual tape transfer to MVS is accomplished using the GETTAPE program. The user must edit the job control language (JCL) in three areas of the program. The first change is in the fifth line where 'VOL=SER=xxxx' appears. The 'xxxx' must be changed to the tape volume number desired. In this case it is changed to S796. The next change is in line six where 'LABEL=(xx,BLP)' appears. The file number is inserted here, so in this

case '05' is used. The last change depends on whether or not this is the user's first tape transfer operation of the day. In line eight 'DISP=(xxx, KEEP)' appears. If this is the first transfer of the day, the user must enter 'NEW', but for all subsequent transfers for that day 'OLD' must be entered. If this change is not made for the later transfers, a duplicate label JCL error will cause the transfer to abort. Once these changes are made GETTAPE is submitted and the transfer takes place. Progress of the job in the batch system may be monitored by entering 'INQ GETTAPE' to which the computer responds with a coded message indicating the current state of the job. The user is notified of the completion of transfer when two bold messages appear on the screen indicating that two files have been spooled to his reader. To read the files, 'RDR' is entered after which the computer asks for a filename and filetype for each file. These names are not important since the files will be erased shortly, so 'X X' and 'Y Y' may be used. The files will be transferred to the user's A disk and can be browsed using the FLIST commands. A successful transfer results in a file which reads '1DATA SET UTILITY-GENERATE-PROCESSING ENDED AT EOD'. The second file is a summary of the transfer operation, the only important line of which is the sixth line below the GETTAPE JCL code. A successful transfer is indicated if this line reads 'STEP WAS EXECUTED-COND CODE 0000'. Once the transfer occurs, the command 'MOVEFILE' is entered to transfer the data from MVS to the D disk. At this time the C disk may be released unless further transfers are planned. The DTED file containing the degree square of data now resides on the D disk and is accessible to the transformation program.

D. DATA TRANSFORMATION

1. TRANS

All transformations are done using the TRANS program which is executed by the FLY EXEC. FLY compiles, loads and runs the program in addition to defining the MASK DATA D1 file into which TRANS loads the transformed data base.

The first MASK DATA file required is the high resolution data centered on 0482000 north, 1223900 west. This data base will span 20 minutes of latitude and longitude, so the appropriate southwest corner is ten minutes south and west of the center or 0481000 north, 1224900 west. The desired transformation interval is three arcseconds.

TRANS is executed by entering 'FLY TRANS'. The FLY exec then displays the compilation messages and FILEDEFs currently in effect. The first input prompt message asks for the desired transformation interval to be entered in columns 1-2. A brief explanation is provided to remind the user of the permissable interval values and the resulting data base dimensions. The user enters '03'.

The next message requests the latitude and longitude of the parent DTED file's southwest corner. The first entry specifies the hemisphere of latitude and the input required is either 'NN' for north of the equator or 'S' for south. The user enters 'NN'. The next prompt requests the latitude value of the corner in degrees, minutes and seconds (DDDMMSS). The user enters '0480000'. The next two messages ask for the hemisphere and value of the longitude of the corner. The user enters 'W' and then '1230000'.

The last two entries requested are the latitude and longitude of the southwest corner of the area to be transformed. In all cases, the hemisphere specification is the same as that of the parent data base, so only the values are requested. The user enters '0481000' and then '1224900'.

TRANS executes and produces the desired MASK DATA file which is stored on the user's D disk. At this time, MASK may be executed. For the sake of organization, however, the user may desire to perform the transformations for all of the required data bases prior to running MASK. If another transformation is to be made prior to executing MASK it is imperative that the existing MASK DATA D1 file be renamed. Otherwise, it will be overwritten by successive transformations. In this example the three arcsecond data base is renamed 'M03 DATA D1' and the next transformation is begun.

The next MASK DATA file to be created uses a six arcsecond interval with a southwest corner chosen so that both the SAM and EW radars fall inside the resulting 40 minute square of data.

As mentioned earlier, some of the transformations in this example may, in practice, be omitted. For example, the user may opt to forego the six arcsecond transformation and go to the nine arcsecond one for the next data base. The terrain characteristics and the tactical situation will determine which data bases are required for any given strike. It is recommended, however, that the three arcsecond data base be used first for each planning evolution since it provides the highest resolution and gives the most accurate value for the site elevation.

The six and nine arcsecond transformations are performed in exactly the same manner as the first one. In order to ensure that both radars are included in the six arcsecond data base a southeast corner is

chosen at 0481000 north, 1225200 west. This data base is renamed 'M06 DATA D1'. The nine arcsecond data base uses 0480000 north, 1230000 west as its corner location and is renamed 'M09 DATA D1'. This last data base covers the largest area which can be produced by TRANS alone. The remaining two by two degree data base requires the use of COMBIN.

2. COMBIN

a. Overview

The procedure for using COMBIN consists of four separate operation. The first is the transfer of the desired DTED data from tape to the D disk. Since one DTED file has already been transferred, three more remain. Next, the data is transformed at an interval greater than nine. Following this, the individual files are assigned to specific FILEDEFs based on their relative geographic positions. Lastly, COMBIN is executed and produces a MASK DATA D1 file incorporating the data from all of the component files.

b. Tape Transfer

Tape transfer is accomplished exactly as before, except that the GETTAPE JCL must be updated to conform to the desired tape volume and file numbers and the disposition must be amended to 'OLD,KEEP'. In this example, the user need not change the volume number right away since the S-796 tape is used again, but the file label number must be changed from '05' to '02'. To transfer the remaining two files on tape S-798, the volume identifier must, of course, be changed.

As a practical matter the tape transfer of the second DTED file should be postponed momentarily. The reason is that the first TAPE DATA D1 file is still on the D disk and will be overwritten if a subsequent

tape file is transferred. The most efficient procedure is to transfer the first file as previously described, then amend the GETTAPE JCL for the next file and submit GETTAPE. During the time required for GETTAPE to transfer the tape file to MVS the user performs the appropriate transformation of the existing TAPE DATA D1 file and renames the resulting MASK DATA D1 file. By this time, the prompt message should arrive indicating that the second file is ready to be moved from MVS to the D disk. If the file is sent to MVS before the user is ready for it, the file will remain in MVS until the user has completed the last transformation. In any event, the new file will not be transferred onto the D disk until the user commands 'MOVEFILE', at which time the new file will overwrite any previous data on the TAPE DATA D1 file. Following the 'MOVEFILE' command the user again amends the GETTAPE JCL and renews the cycle which continues until all required files have been processed.

c. Transformation

The second operation in the combining procedure is the transformation of the TAPE DATA D1 file. This is accomplished using TRANS as before, except that the transformation interval is increased. For this example an interval of 18 is used during the combining process. Upon commanding 'FLY TRANS' a message will appear asking for the interval. The user enters '18'. The latitude and longitude of the corners of both the parent DTED file and the desired area of transformed data are entered, keeping in mind that when transforming data for use by COMBIN the corner position of the transformed data base will always be the same as the parent file. The MASK DATA file produced by TRANS is, in this case, one quarter the size of a normal MASK DATA file.

d. FILEDEF Assignment

The next operation is FILEDEF assignment. The user must assign each transformed file to an appropriate FILEDEF based on the geographic position of the file relative to its neighbors. In the combining process FILEDEFs are assigned sequentially from west to east starting with the northern squares and moving southward. In the current two by two degree example, the data from S-796 number 2 is assigned to FILEDEF 11, S-796 number 5 to FILEDEF 12, S-798 number 2 to FILEDEF 13 and S-798 number 5 to FILEDEF 14. Combinations of more squares follow the same pattern with the northwestern file assigned the lowest FILEDEF number and the southeastern one the highest. The FILEDEFs for all permissable data bases up through a five by five degree square are contained in the FLY EXEC. FILEDEFs 11-14 are reserved for the two by two square, 15-30 for the four by four and 31-55 for the five by five. Each component file is identified according to the pattern 'Mxxyyyzz DATA D1', where 'xx' is the southwest corner latitude in degrees, 'yyy' is the longitude and 'zz' is the interval of transformation used. In this example, FILEDEF 11 reads 'M4812418 DATA D1', FILEDEF 12 reads 'M4812318 DATA D1' and so on. Therefore, the first 18 arcsecond data file transformed in this example is renamed 'M4812318 DATA D1' prior to transferring the next file from MVS. After this operation the first TAPE DATA D1 file is no longer needed and may be overwritten or erased as desired.

e. Combining Files

At this point in the example all four DTED files have been sequentially transferred from tape, transformed and assigned to appropriate FILEDEFs. The user now enters 'FLY COMBIN'. The first prompt message is

a summary of the required transformation and FILEDEF assignments just described. The next message requests the transformation interval used on the component files. The user enters '18' in this case. The next four messages ask for the hemispheres and values of the latitude and longitude of the southwest corner of the desired combined data base. In this example the user enters the four responses 'NN', '0470000', 'W' and '1240000'. COMBIN then combines the previously transformed component files and produces a MASK DATA file on the D disk. In order to differentiate this data base from the others the nomenclature 'Cxxyyyzz DATA D1' is used where 'xx' and 'yyy' are the latitude and longitude of the data base southwest corner and 'zz' is the number of degree squares contained in the file. In this case, the user renames the file 'C4712404 DATA D1'. There are now four data bases of varying resolution stored on the D disk ranging from the 20 by 20 minute square to the two by two degree combined data base.

E. EXECUTING MASK

1. Input Data

The user is now prepared to execute MASK. The high resolution M03 DATA D1 file is selected for processing first and is renamed 'MASK DATA D1'. The user commands 'FLY MASK' and the input prompt messages begin. The first four messages request the hemispheres and values of the latitude and longitude of the first radar site. The user inputs the four separate responses 'NN', '0482000', 'W' and '1223900'. The next message asks for the elevation of the first site in feet MSL. If the elevation is not known, the user enters '-9999'. In this example '-9999' is the correct response. The next message asks for the first site antenna mast height above the ground. If this value is unknown a response of '-99' sets the height to a value of

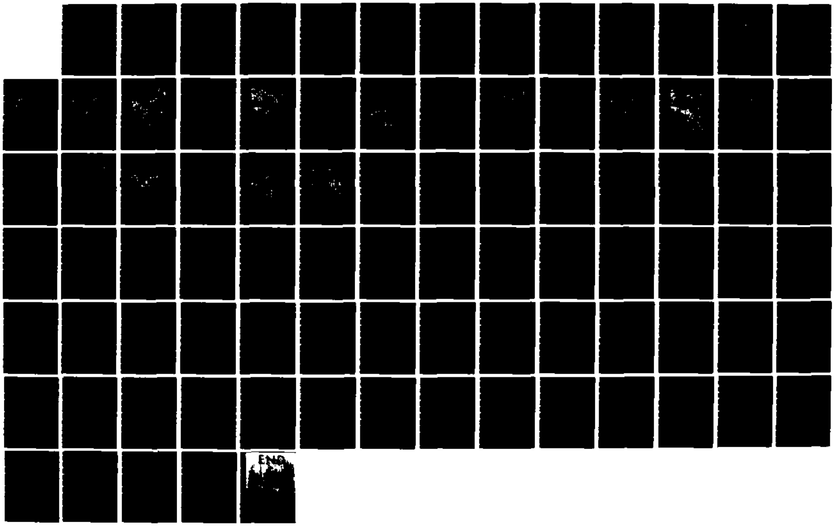
five meters. In this example, '020' is entered. The last radar site parameter requested is the first site radar PRF. If the user does not desire a maximum unambiguous range limit imposed, the proper response is '-999'. In this example the correct entry is '1250' since this PRF provides the longest range capability. The next message asks whether or not the user wants to enter additional radar sites. If so, the response is '1'; otherwise a '0' is entered. The user enters '1', since the EW radar remains to be input and the radar input parameter sequence is repeated. The correct entries for the second site are 'NN', '0484800', 'W', '1223200', '-9999', '100' and '0400'. Since a third radar site is not desired, the user enters '0' in response to the additional site message.

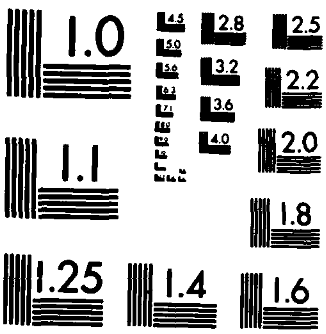
The strike altitudes are input next. The first message in this phase asks for the AGL strike altitude in columns 1-4. If no AGL display is desired '-999' is entered. Since the AGL display is needed the user enters the proposed strike altitude of '0200'. The next message requests the MSL altitude desired. If no MSL display is desired '-9999' is entered. The MSL display is needed in this example so '07000' is entered.

The refractive inputs are entered at this point. The prompt message requests the value of dN/dh in N-units per kilometer including the sign and lists -156 as the minimum permissable value. A value of -039 is used for the standard radar refractive gradient and -020 is the value used to obtain standard day optical refractive effects. Since the IREPS program predicts a dN/dh of -050 through 7000 feet MSL, '-050' is entered. The next message asks for the ducting height. This value is used as the upper altitude bound for applying the input value of dN/dh. At altitudes above this value, dN/dh automatically reverts to the standard value of -039. If IREPS had predicted ducting, the user would input the predicted height, but

AD-A136 771 MASK: A TACTICAL AID FOR PLANNING AIR STRIKES AGAINST RADAR DEFENDED LAND TARGETS(U) NAVAL POSTGRADUATE SCHOOL MONTEREY CA D B MCKINNEY SEP 83 2/2

UNCLASSIFIED F/G 15/3 NL





MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

since this is not the case the user enters the upper altitude for which dN/dh was calculated or '07000'.

The last input required is the selection of the topographic display. If the user desires the display, a '1' is entered. Otherwise, a '0' is used. In this case the user enters '1'.

MASK now begins its calculations based on the inputs. For each two seconds of CPU run time the word 'CRANKING' appears on the screen. When the calculations for any given site are finished a message will appear on the screen stating, 'CALCULATIONS COMPLETE FOR x OF y RADAR SITES', where 'x' is the number of sites processed thus far and 'y' is the total number requested. When 'x' equals 'y' the calculations for all sites are complete and the results are stored in the MASK OUT D1 file. To browse the output, the user enters 'FLIST ** D' and uses standard FLIST commands. To print the output from FLIST, the command 'PRINT /(CC' is used. After running MASK using the high resolution data base, MASK DATA D1 is renamed 'M03 DATA D1' and M06 DATA D1 is renamed 'MASK DATA D1'. MASK is again executed with the new data base and the output is spooled to the printer. This sequence is repeated for each of the data bases in turn and then the output is analyzed. It is prudent in most cases not to erase data bases after they have been used by MASK, since it is likely that some additional runs will be required due to strike altitude modifications based on the initial output or additional intelligence on the threat.

2. <u>Output Analysis</u>

a. Topographic Displays

The topographic display consists of an 80 by 80 character matrix displaying terrain features and a short legend explaining the elevation code. Figure 5.1 shows the elevation code legend. All

```
                    CODED TOPOGRAPHIC MAP OF AREA
SOUTHWEST CCRNER IS W 1230000   NN 480000
GRID SPACING=15 MINUTES.

                          LEGEND
      SYMBOL          ELEVATICN (METERS)
        .              SEA LEVEL
        K                    50
        L                   100
        M                   200
        N                   300
        O                   500
        P                   700
        Q                   900
        R                  1100
        S                  1300
        T                  1500
        U                  1800
        V                  2100
        W                  2400
        X                  2700
        Y                  3000
        Z                  3000 PLUS
```

Figure 5.1 Topographic Display Legend

elevation values are in meters above sea level. The code symbol represents the upper limit of the elevation. For example, the '.' represents all areas which are at or below sea level, while the 'K' represents all areas which are above sea level but less than or equal to 50 meters. The only exception to this rule is the symbol 'Z' which represents areas greater than 3000 meters. Areas which are blank fall in the same elevation bin as the lowest symbol which borders on them. Blank areas correspond to areas where the terrain variation is very slight such as broad valleys or plains.

In the runs of MASK four separate topographic displays were created at various levels of resolution. The first of these was a high resolution 20 by 20 minute display centered on the SAM radar site. This display is shown in Figure 5.2. The display has been annotated to show the radar site in the center of the display and the target bridge due north of the site. This display shows the relatively flat terrain in the immediate vicinity of the site. The ground elevation rises gradually to the south, more steeply to the east and some substantial elevation changes are indicated by the denser code on the northern side of the bridge. The shoreline is easily discernable. Each symbol in the display is approximately one quarter of a nautical mile in height and each grid box is five nautical miles long and approximately three and a third nautical miles wide.

The next topographic display created was the 40 by 40 minute area which included both radar sites and is shown in Figure 5.3. This display covers four times the area of the previous one and gives a better idea of the overall nature of the terrain surrounding the target. The islands to the northwest of the bridge are seen to rise steeply to

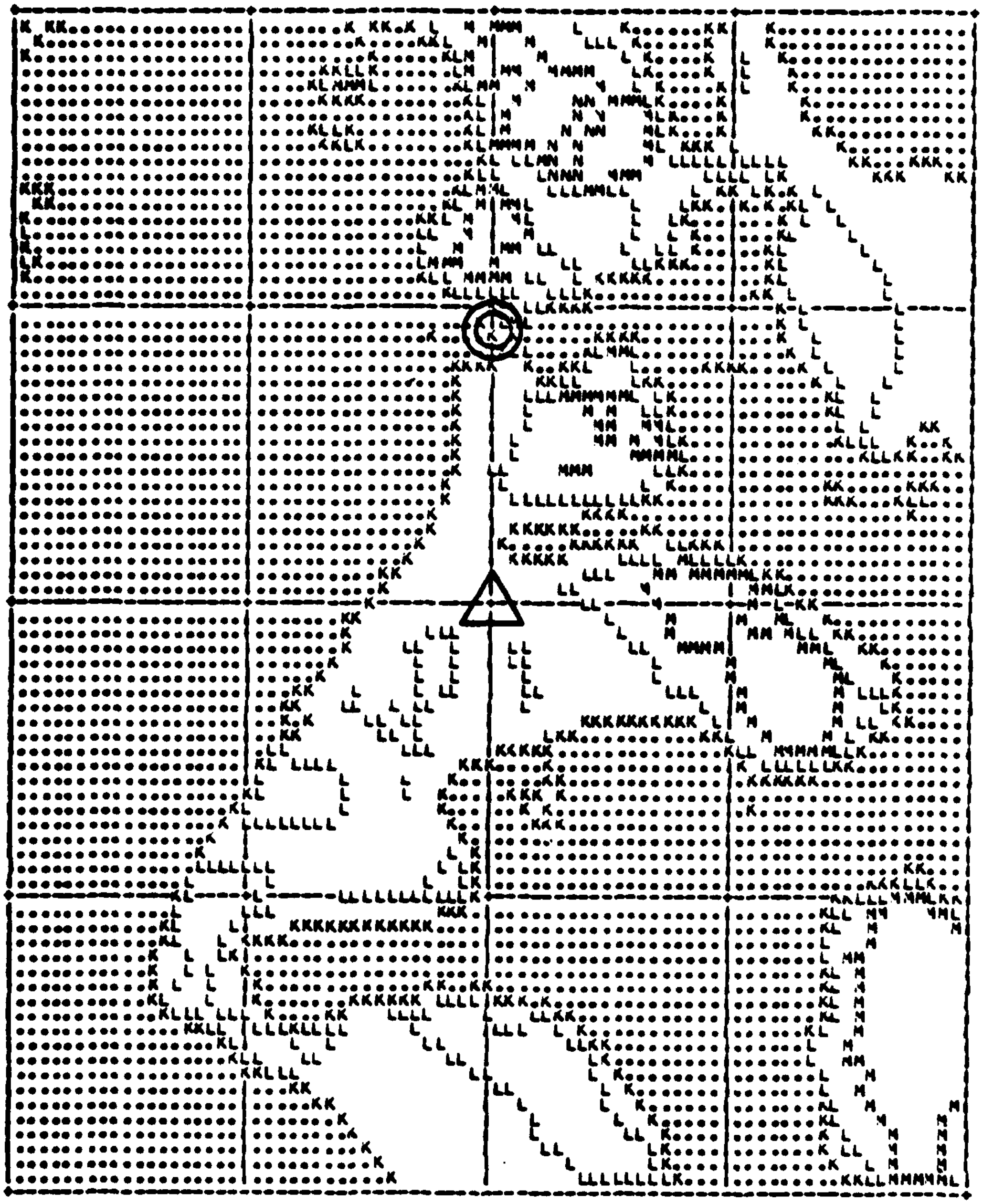


Figure 5.2 20 Minute Square Topographic Display

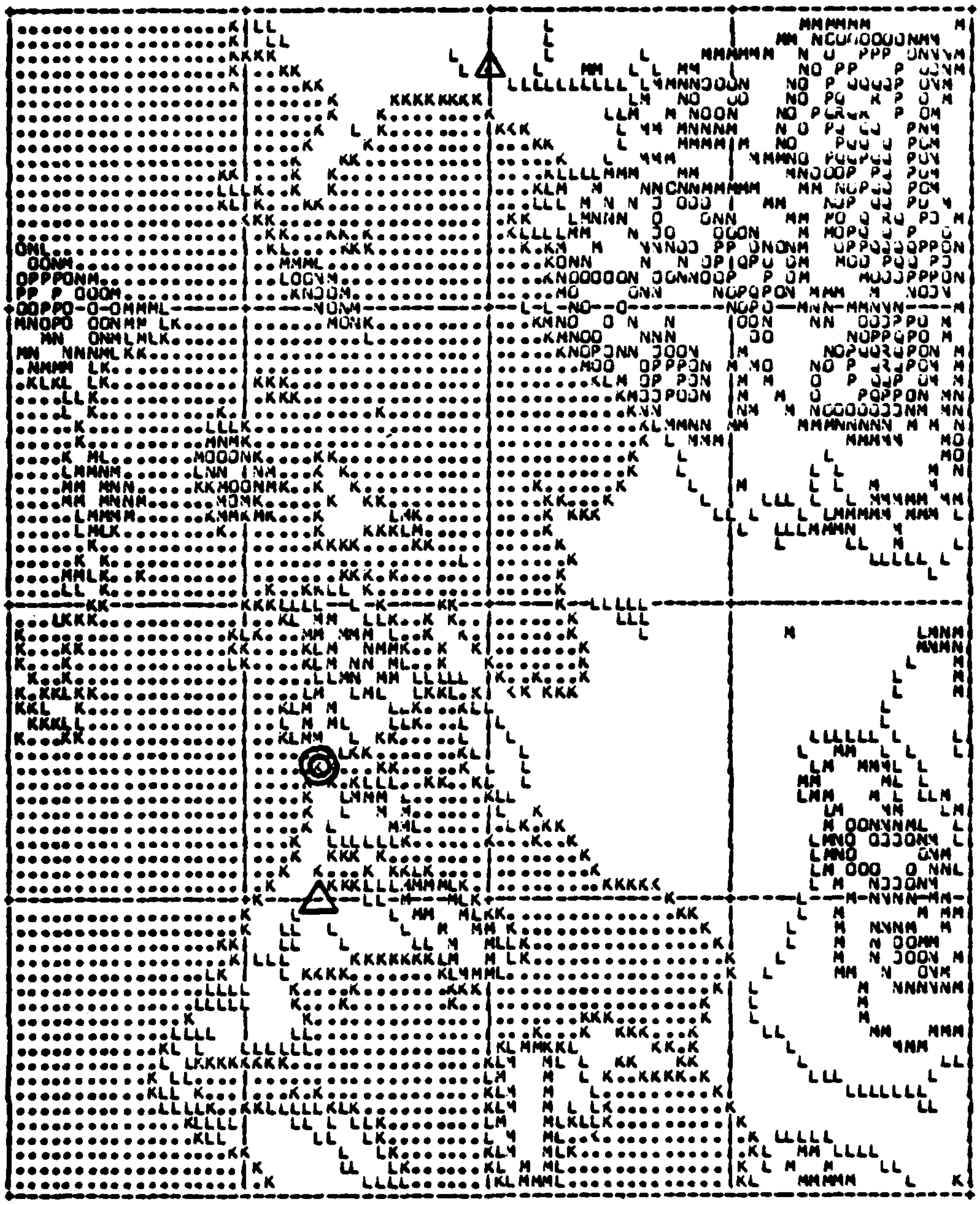


Figure 5.3 40 Minute Square Topographic Display

elevations as high as 700 meters (2300 feet) above the sea. The mainland is essentially flat with a prominent mountainous area in the northeast corner and a lower set of hills near the southeast corner. These are the foothills of the Cascade Mountains.

The next topographic display is shown in Figure 5.4. It covers an area nine times the size of the first and again shows the flat coastal areas with mountainous terrain to the east. A major river valley separates the two areas of high terrain and extends eastward from the coast halfway up the display. Another area of steep terrain has appeared across a straight from the radar site in the southwest corner of the display.

The final topographic display covers a two by two degree square area and is shown in Figure 5.5. The mountainous area which first appeared in the southwest corner of the previous display has emerged as a significant mountain range rising steeply from the sea. This is the Olympic Peninsula. The area of water to the west of the site extending to the eastern edge of the display is the Strait of Juan de Fuca and is about 15 miles wide. The channel to the south of Whidbey Island is the southern portion of Puget Sound. This channel passes by Seattle one quarter of the way up from the bottom of the display and reaches nearly to the hypothetical rendezvous point in the middle of the bottom of the display. The southeastern tip of Vancouver Island occupies the northwest corner of the display.

These four displays will be used in conjunction with the AGL and MSL masking displays. The masking displays contain no terrain information by themselves and are designed to be traced directly onto the topographic displays for interpretation. An alternate method is to make

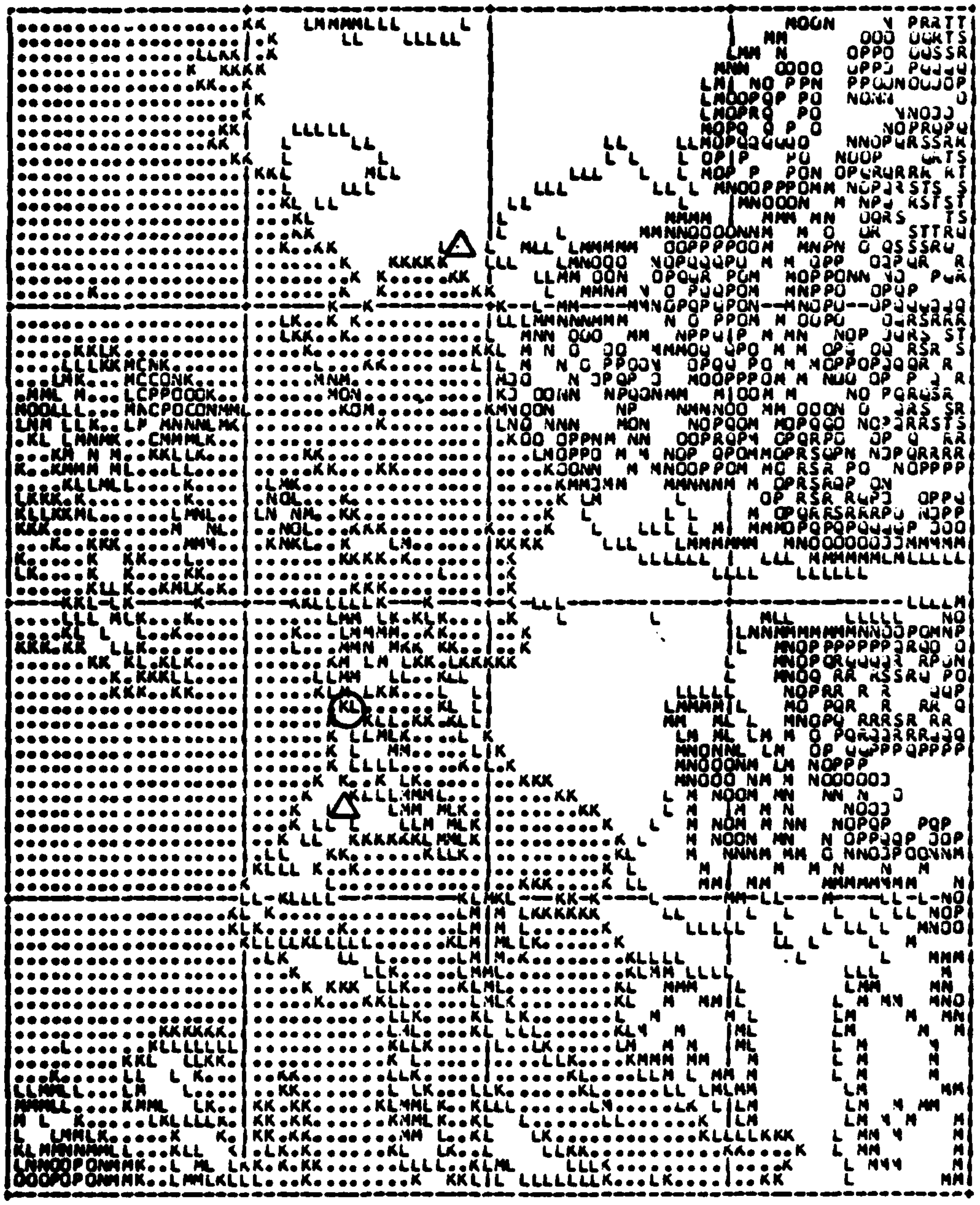


Figure 5.4 60 Minute Square Topographic Display

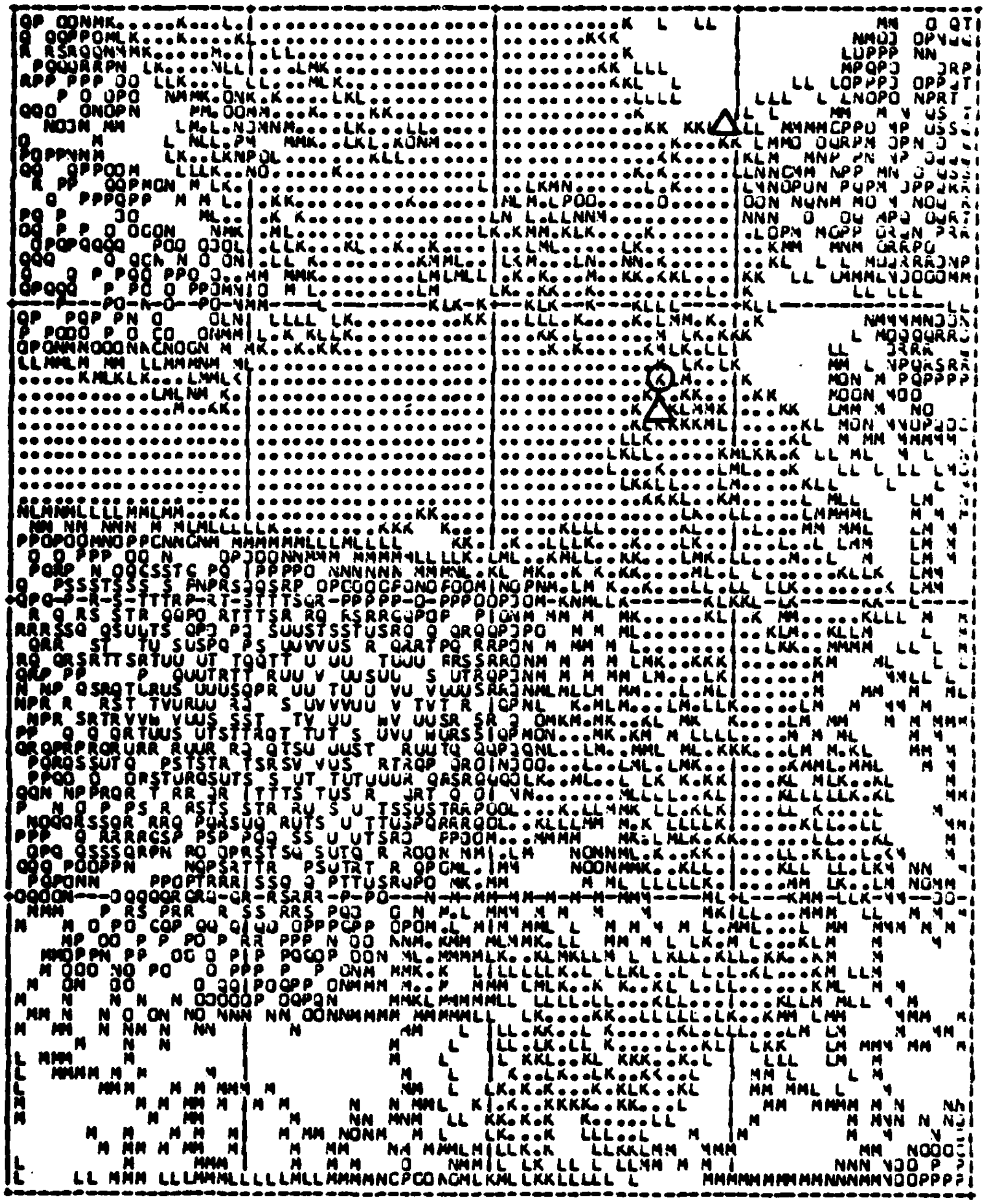


Figure 5.5 Two Degree Square Topographic Display

transparent overlays of the masking displays and place them over the topographic displays. In the remaining examples the figures shown will be combinations of the masking envelopes and the appropriate topographic displays since the envelopes by themselves are not very informative.

b. AGL Displays

The AGL display consists of an 80 by 80 element matrix and a descriptive page. The descriptive page contains information describing the parameters of the display, radar site parameters and a brief legend of the display matrix symbols. Figure 5.6 is the descriptive page for the first run of MASK in this example.

The AGL masking envelope for the first MASK run is shown in Figure 5.7. The envelope is based on information only from the SAM radar site. It can be clearly seen that the radar coverage extends primarily to the northwest of the site, with the areas to the south and east being masked by rising terrain. The target lies just on the border of the envelope and appears to be approachable from the east. The small unmasked area to the north of the target is formed by an isolated peak which rises steeply from the surrounding terrain. This run of MASK will be the most accurate of any in this example due to the relatively high density of data points in any given area. It will become apparent later that the interpolated value of site elevation varies between the different resolution data bases. For this reason, the user should note the elevation values from the high resolution runs and use them as inputs in following runs as required. In any event, the information from this display indicates that a strike approaching at 200 feet AGL from the south or east will be undetected until just prior to reaching the target.

RADAR COVERAGE DISPLAY FOR STRIKE AT 200 FEET ABOVE GROUND LEVEL

I. DISPLAY PARAMETERS

SOUTHWEST CORNER OF DISPLAY:LATITUDE= 481000 NN
LONGITUDE=1225200 W

GRID SPACING=10 MINUTES

CELL RESOLUTION:LATITUDE= 0.5005 NM
LONGITUDE= 0.3297 NM

REFRACTIVE GRADIENT = -50

REFRACTIVE DUCT HEIGHT (FT) = 7000

II. RADAR SITE PARAMETERS

SITE #	LATITUDE	N/S	LONGITUDE	E/W	ELEVATION (FEET)	PRF
1	482000	NN	1223900	W	69.21	1250
2	484800	NN	.1223200	W	237.80	400

III. LEGEND

##=NUMBERED RADAR SITE LOCATION

**=ENVELOPE WITHIN WHICH AN AIRCRAFT FLYING AT THE SPECIFIED ALTITUDE WILL BE UNMASKED AND INSIDE THE RADAR MAXIMUM UNAMBIGUOUS RANGE.

Figure 5.6 Typical AGL Descriptive Output Page

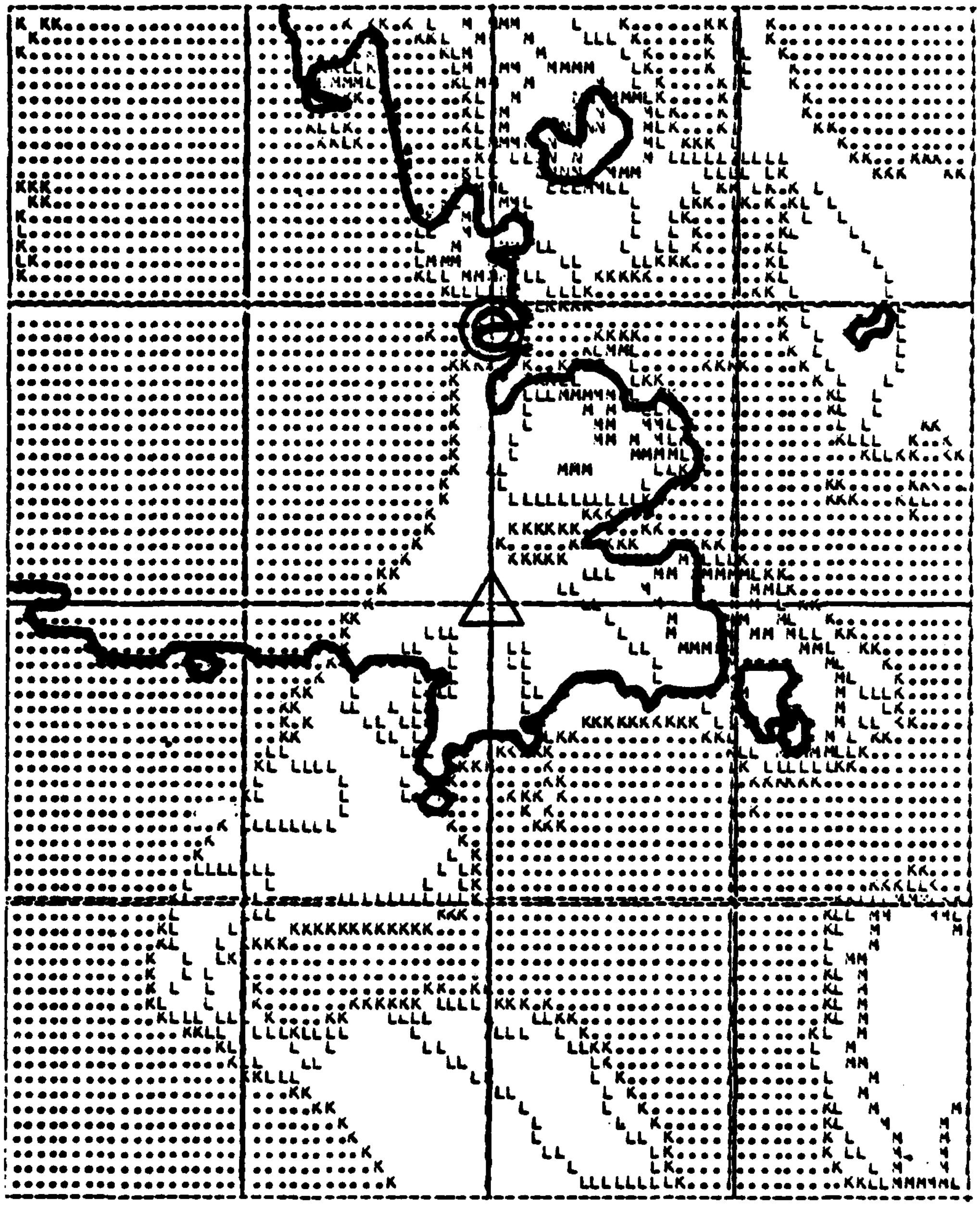


Figure 5.7 20 Minute Square AGL Display

The AGL display from the second run is shown in Figure 5.8. This display includes the masking envelopes formed by both of the radars. The most critical change in this display is the addition of an area of coverage to the east of the target provided by the EW radar. The positioning of the EW radar allows it an unimpeded field of view directly south over the water. In addition, it has increased the coverage on that part of Whidbey Island directly east of the site, making an undetected approach virtually impossible. Still, the time that the aircraft must spend in the SAM envelope is short. The area over the mainland is predominantly free of coverage due to the masking of the EW radar by the high terrain in the northwest corner. Other masked areas are caused primarily by the vertical extent of the islands to the north of the target. In particular a large, roughly diamond shaped area of masking is shown over water in the upper left of the display. This area is masked by tne long thin island which forms its northeastern side. Masking boundaries in the upper half of the display are seen to extend radially from the location of the EW site. This effect is even more pronounced in Figure 5.9 which is an evelope of the coverage of the EW radar only, using the 60 by 60 minute data base. The other point of interest in Figure 5.9 is that the additional area of coverage on Whidbey Island to the east of the SAM site which first appeared in Figure 5.8 is due to the EW radar. The SAM coverage is confined to that area depicted in Figure 5.7.

The next AGL display is from the third run and is shown in Figure 5.10. There are no significant tactical points contained in this display, other than to show that the AGL coverage does not extend any farther south than was shown in Figure 5.8. From the point of view of

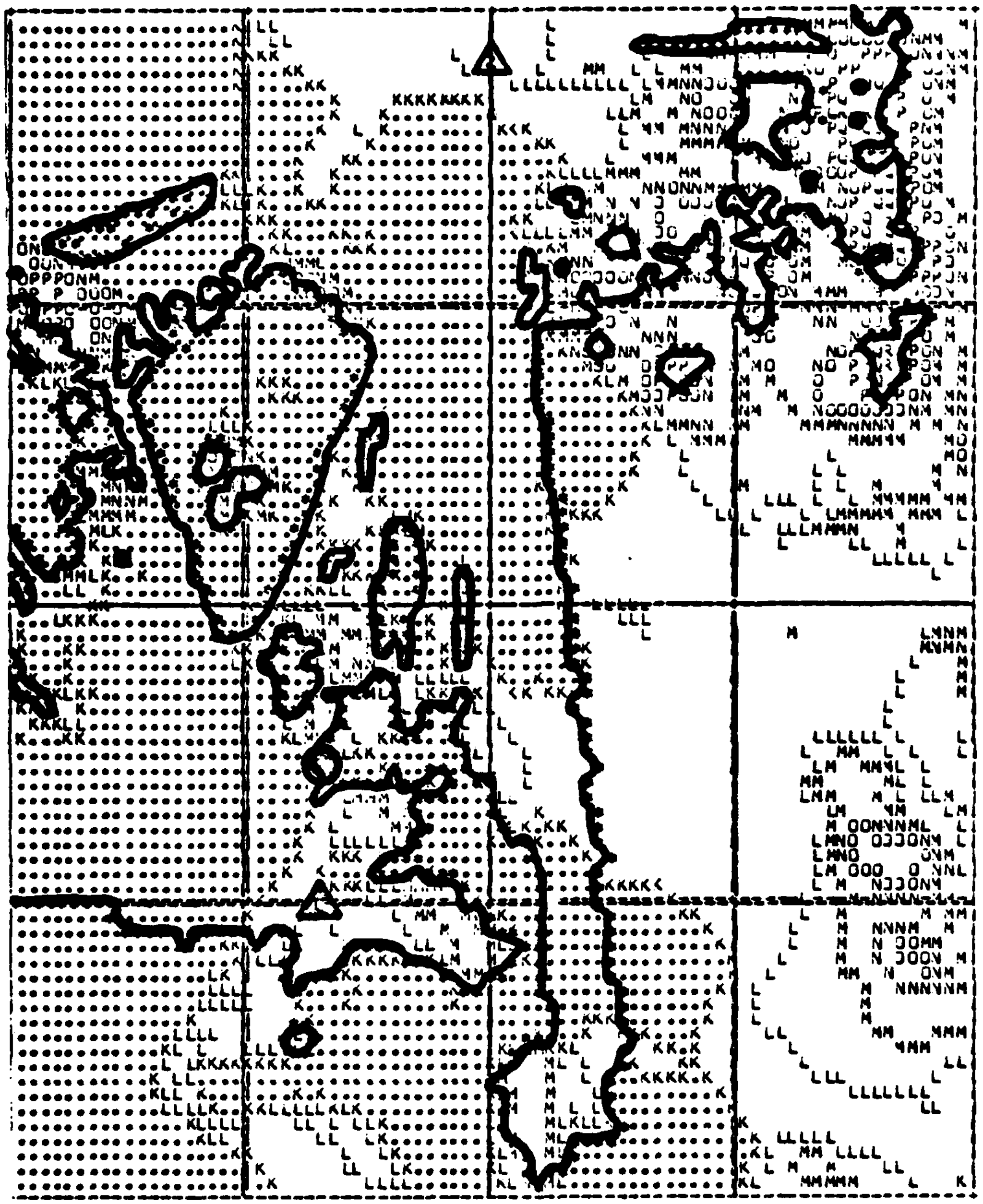


Figure 5.8 40 Minute Square AGL Display

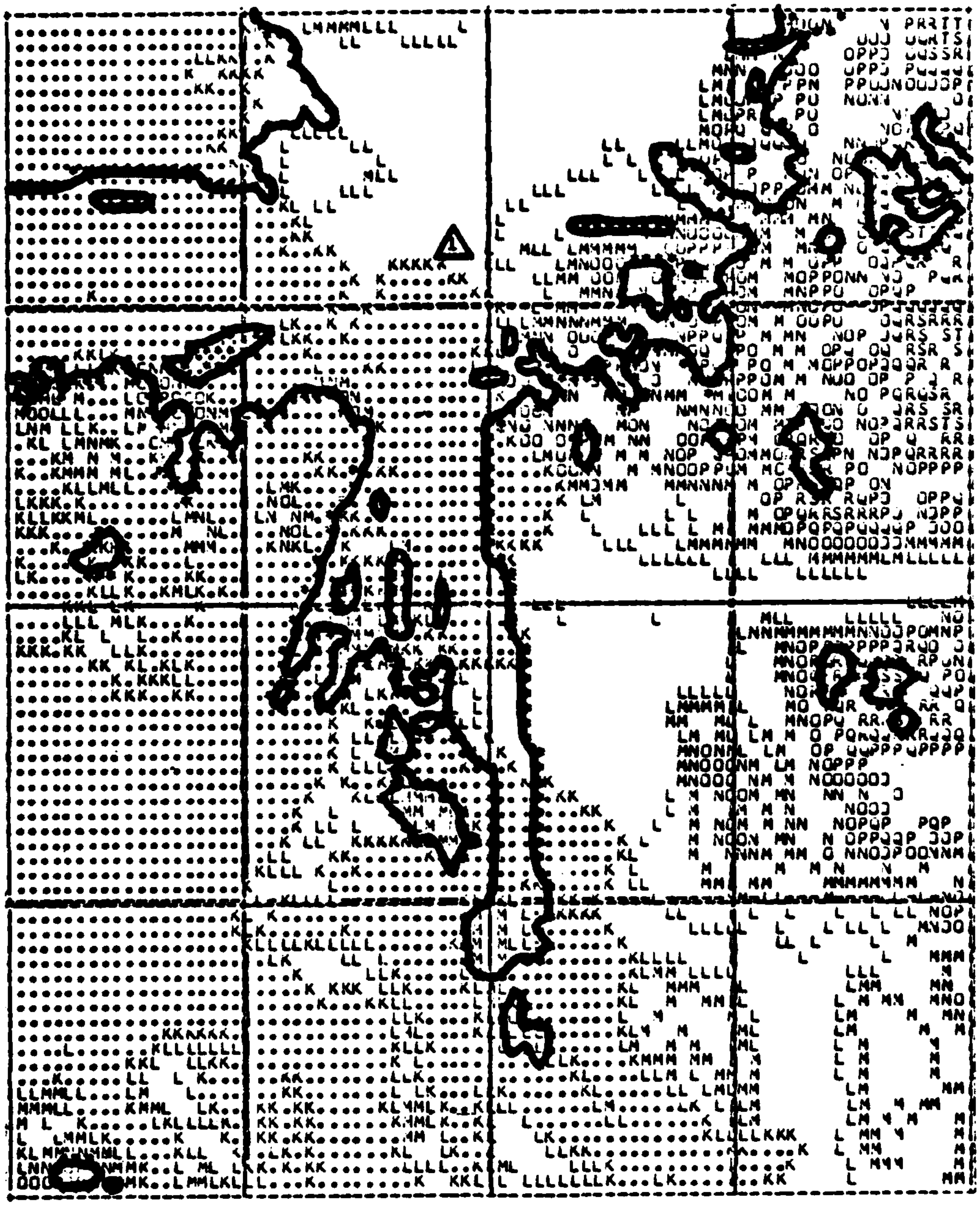


Figure 5.9 AGL Masking Envelope for EW Site Only

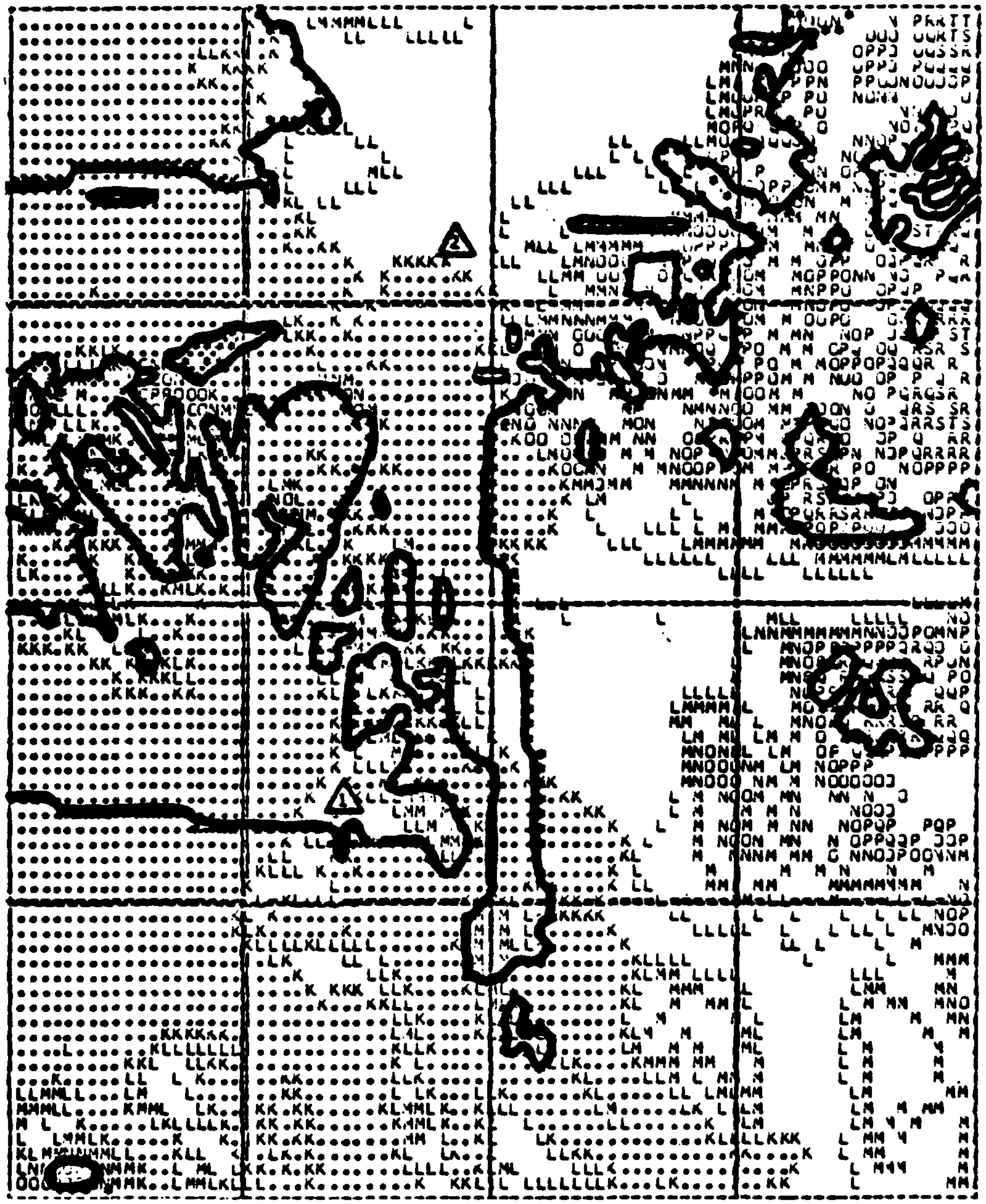


Figure 5.10 60 Minute Square AGL Display

MASK performance it is significant to note that the shapes of the envelopes have not changed appreciably even though the data base resolution has decreased by a factor of nine from that in Figure 5.7. The details of some of the envelopes have begun to fade due to the display resolution, but on the macro scale the same basic planning information shown in Figure 5.7 is also contained in Figure 5.10, which covers nine times as much area. This trend is continued in Figure 5.11 which is the final AGL display. Much of the detail shown in the earlier AGL displays is gone, but the tactical picture has been preserved. It is obvious from this last display that the bombers should approach generally from the south and east.

A suggested strike route of flight is to proceed up Puget Sound at 200 feet hugging the eastern shore until reaching a point 15 miles east-southeast of the bridge. The strike should then turn directly towards the bridge accelerating in preparation for weapon delivery maneuvers. After weapon release the aircraft should regain low altitude and exit the target area with a right turn to the east-northeast until passing the coastline. At this time they may turn south and return to base.

c. MSL Displays

The MSL display contains the same general information described in the AGL display discussion, except that the masking envelope is determined by the MSL masking height and the MSL strike altitude is used. The only difference in the display symbology is the addition of the special symbol for areas of terrain which exceed the strike altitude.

In the example, the 7000 foot MSL strike altitude produced MSL displays which were blank in all runs except the one which used the

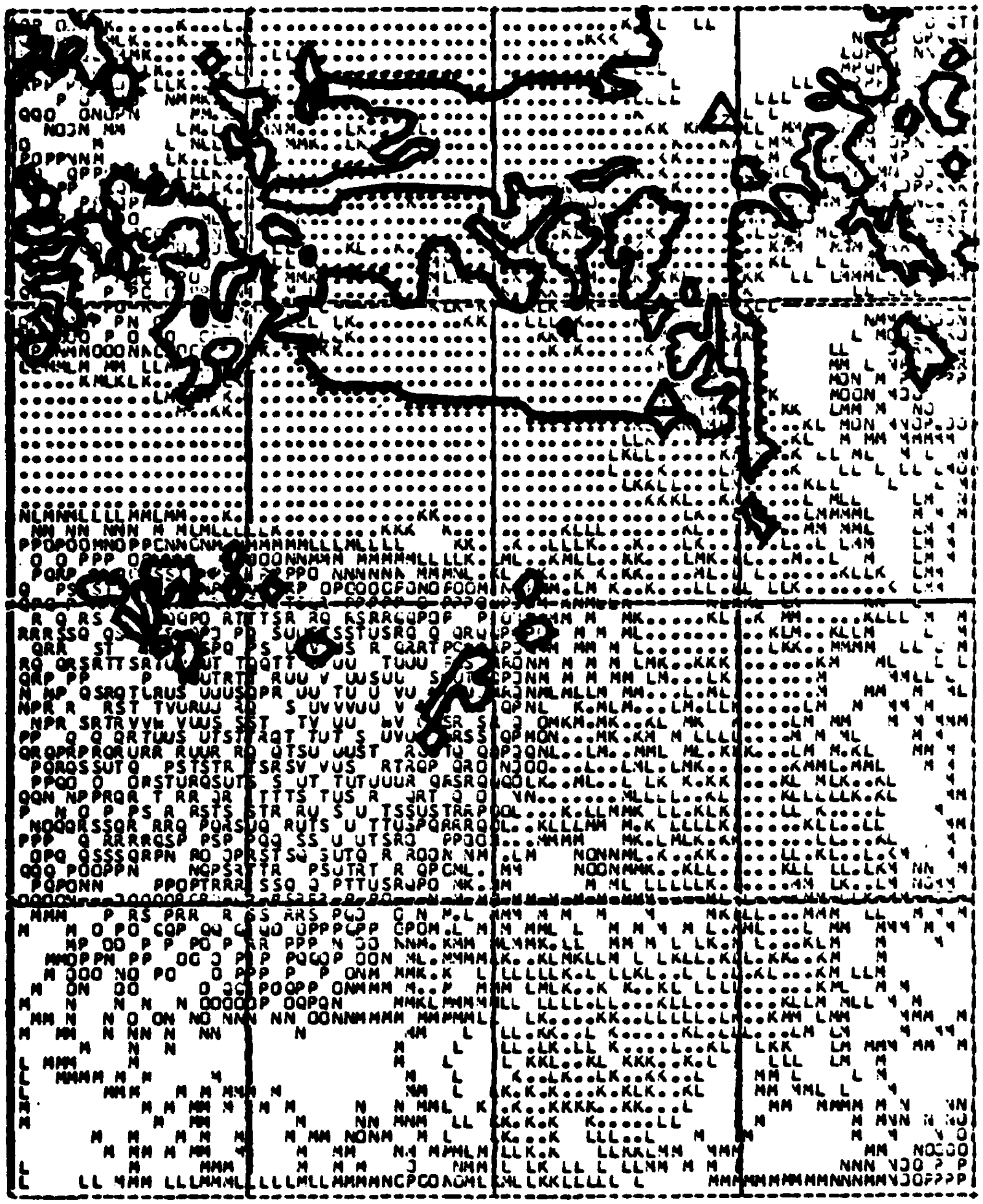


Figure 5.11 Two Degree Square AGL Display

2 by 2 degree data base. This means that the strike aircraft were inside the masking envelopes at 7000 feet at any point on the MSL displays during each of the first three runs. Figure 5.12 shows the MSL display from the last run. This display clearly shows that the 7000 foot strike altitude creates a masking envelope which covers all of the displayed area above 48 degrees. The area in the southwest corner of the display shows a large area of masking due to the obstruction provided by the Olympic Mountains. An unmasked corridor extends southward from the radar sites to the southern border of the display. This clear area results primarily from the fact that much of the area due south of the sites is water or low lying coastal tidal flats. It should be noted that the rendezvous area near the middle of the southern border of the display is shown to be masked at 7000 feet. This will permit the strike elements to rendezvous outside the detection area of the EW radar and thus deny the defense any early strike composition information.

d. Conclusions

Based strictly on the displays obtained thus far the following conclusions may be made. First, the strike can rendezvous at 7000 MSL outside of the defense's detection capability. Second, any movement to east from the rendezvous area will take the aircraft into an unmasked area at 7000 MSL. Third, the AGL display clearly shows that the aircraft can penetrate nearly to the target at 200 feet AGL while avoiding detection of any kind. Last, the SAM radar area coverage is restricted solely to the northwest quadrant.

A suggested strike tactic based on MASK's output is to send the bombers on the profile discussed in the AGL display discussion and

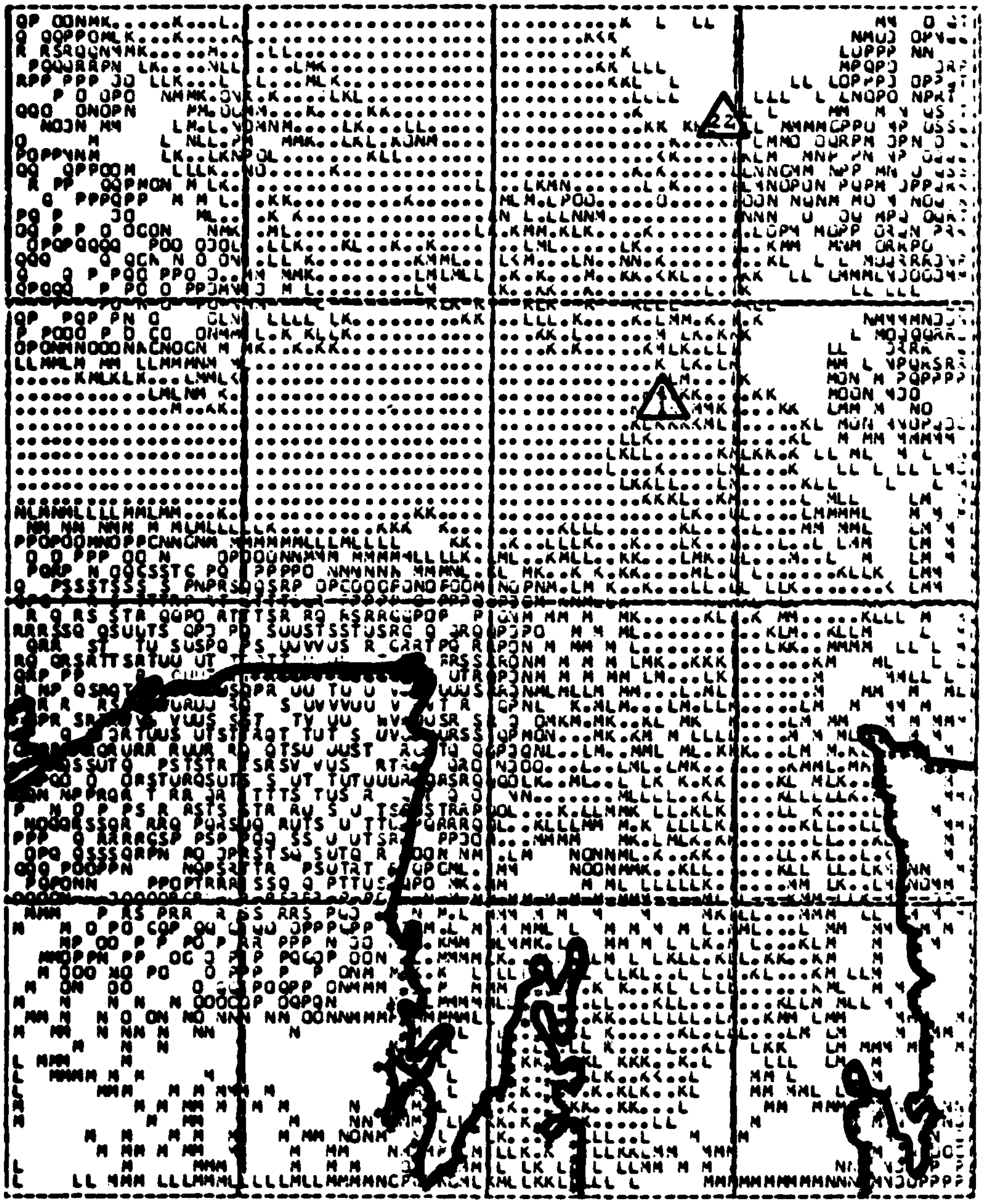


Figure 5.12 Two Degree Square MSL Display

send the chaff, jammers and anti-radiation assets to the northwest. The bombers should descend immediately in order to escape initial detection as they head northeast. The other elements should proceed at 7000 feet to arrive at the point on the MSL display where the area of masking in the southwest corner is closest to the target. The sudden appearance of this decoy force in concert with the use of chaff and jamming will attract the attention of the defense to the southwest while the bombers achieve surprise from the east. The speeds of the various elements should be planned to place the decoy force so that it appears on the victim radar displays shortly before the bombers make their final turn inbound to the target.

Additional MASK runs may be desired in order to more precisely define the point at which the bombers must be at low altitude. Examples of such additional runs are presented in the following section and reveal that the bombers may remain at a confortable altitude of 2000 MSL until very close to the target if they follow the previously described strike profile.

F. ADDITIONAL EXAMPLES

1. General

This section presents several examples which illustrate the effects of changing certain parameters during the input phase of MASK. For clarity and ease of comparison, all examples use only the EW site as a basis for constructing the masking envelopes.

2. Antenna Height Variation

The first comparisons show the effect of varying the radar antenna height. Figure 5.13 shows the masking envelope for a 200 foot AGL target

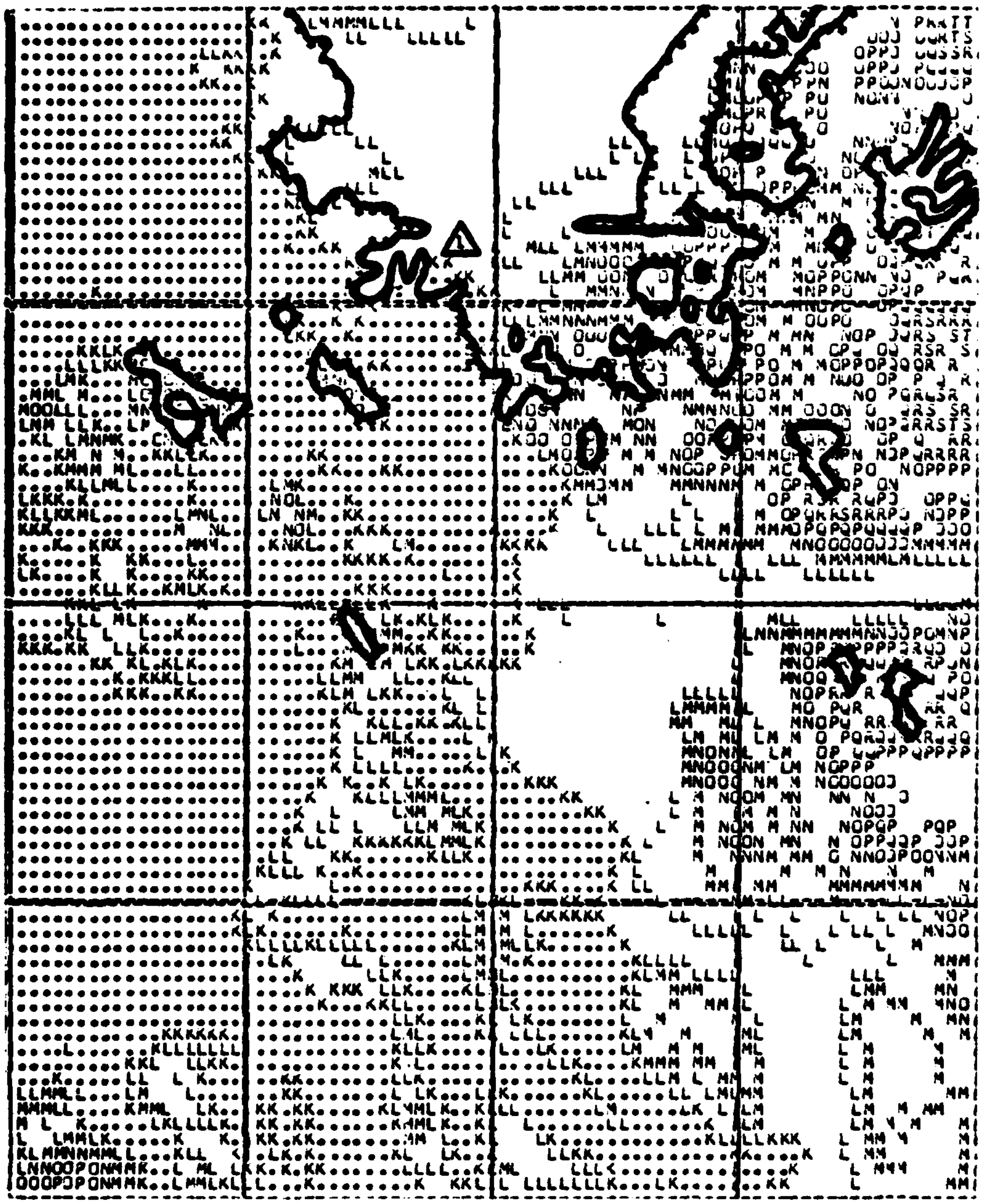


Figure 5.13 Low Antenna Height Example

against the EW site with the following parameters: display coverage is 60 by 60 minutes, PRF is 400, dN/dh is -050, duct height is 7000 MSL and antenna height is 20 feet AGL. Figure 5.14 is an identical display, except that the antenna has been raised to 100 feet AGL. The most pronounced effect is to markedly increase the coverage to the west and south. However, the large masked areas remain to the southwest and southeast. Figure 5.15 shows a 2 by 2 degree display of the same situation in which the radar antenna has been raised to an altitude of 5000 feet MSL to simulate an airborne surveillance capability. The coverage of the radar has vastly expanded in this example. The entire area shown in Figure 5.14 is contained in the four northeastern grid blocks of Figure 5.15 and indicates that the only areas of significant masking are found in and behind the mountains of the Olympic and Cascade ranges.

3. <u>PRF Variation</u>

The next example shows the effect of changing the radar PRF, thereby changing the maximum unambiguous range of the radar. The baseline example is Figure 5.14 in which a PRF of 400 is used. Figure 5.16 shows the same display except that the PRF has been increased to 5000. Theoretically, this value produces a maximum unambiguous range of approximately 16.2 nautical miles. Examination of Figures 5.14 and 5.16 show that the two displays are identical except that Figure 5.16 is truncated at a displayed range of 16.5 nautical miles, the difference from the theoretical value being due to the resolution of the display.

4. <u>Refractive Effects</u>

Changes in the refractive gradient are illustrated in the next examples. The baseline case used is Figure 5.13, in which -050 is used

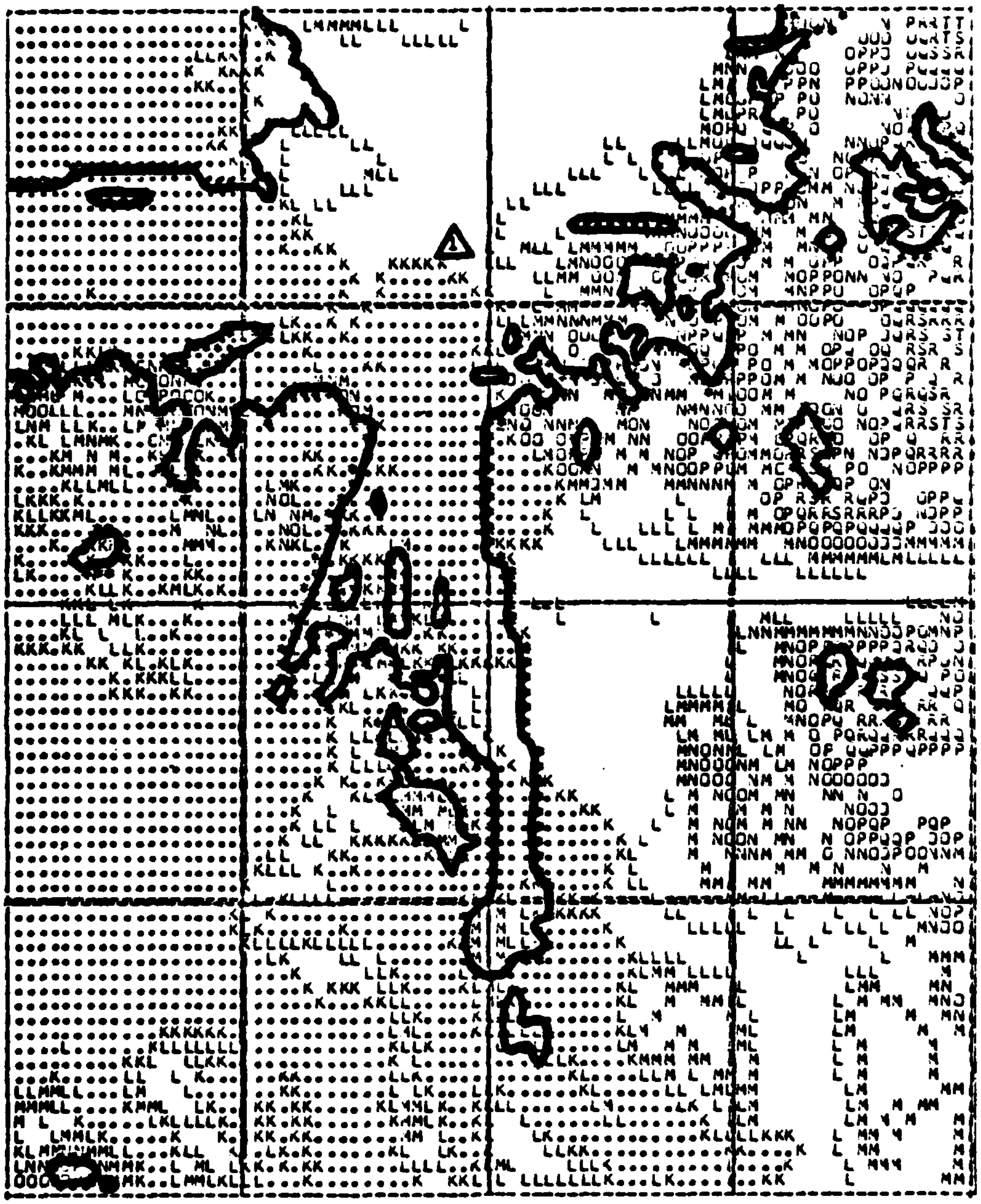


Figure 5.14 Medium Antenna Height Example

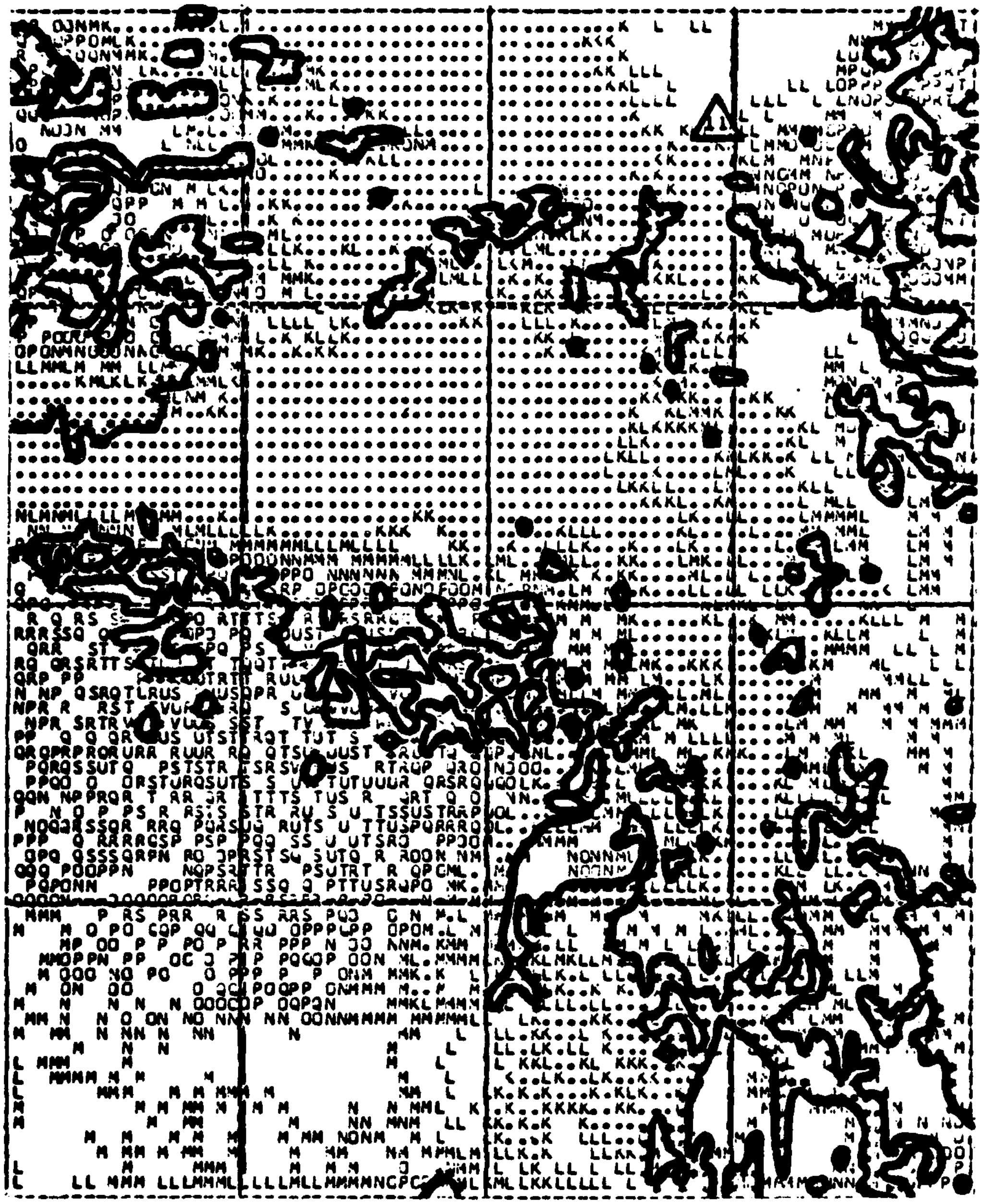


Figure 5.15 Airborne Antenna Height Example

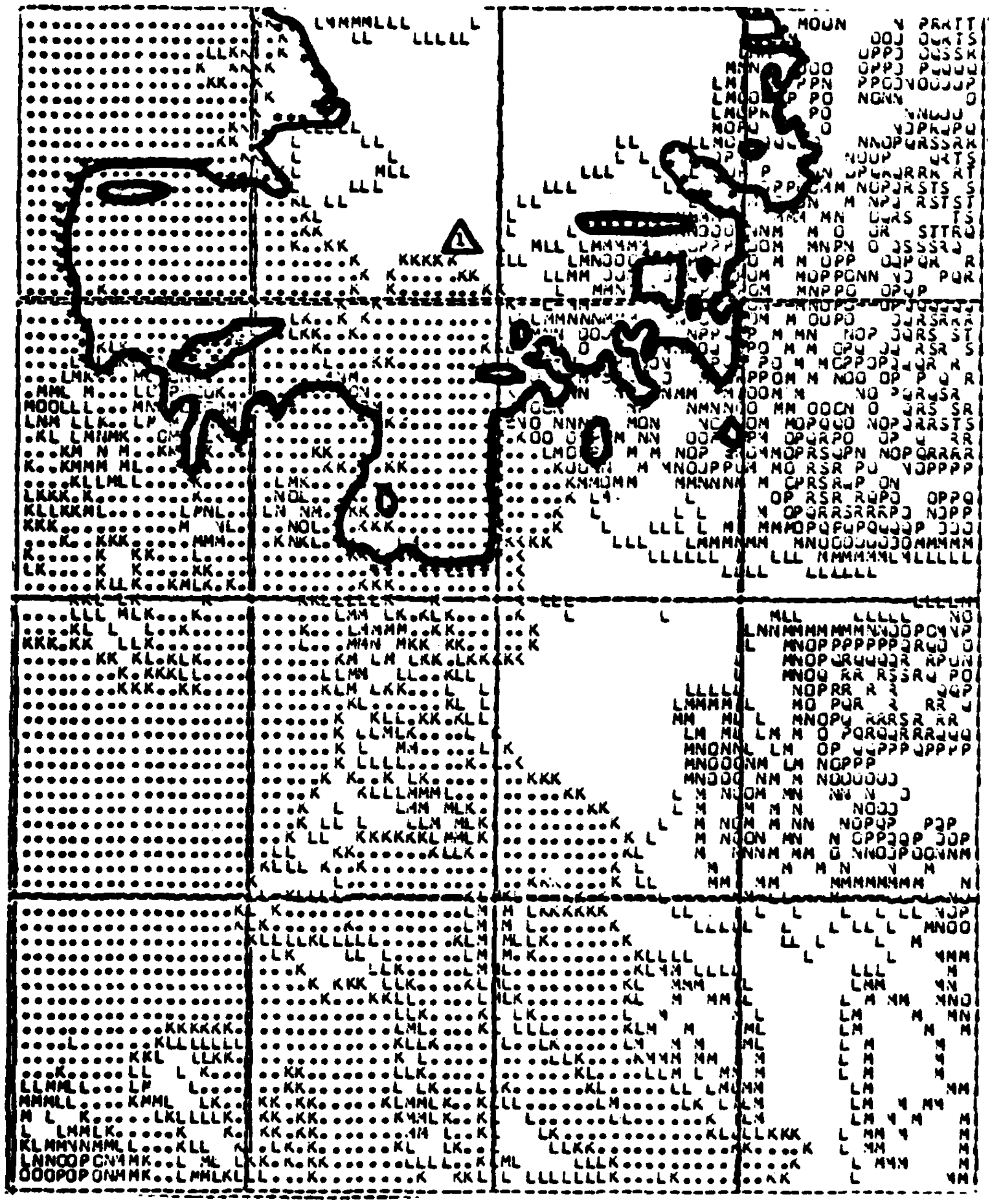


Figure 5.16 PRF Limitation Example

as a value for dN/dh. Figure 5.17 is an identical case except that dN/dh has been changed to -020 which is the value used to simulate standard day optical propagation. With a few minor exceptions the displays appear to be identical and only careful examination shows that some of the masking boundaries are closer to the site in the optical case. This is not a very surprising result since both values of dN/dh fall in the 'normal' propagation range and the radar coverage is primarily limited to short ranges by the low antenna height. In the next example, a noticeable change takes place and serves to further explain the similarity of Figures 5.13 and 5.17. This example is shown in Figure 5.18. All parameters are identical to Figures 5.13 and 5.17 except that dN/dh has been changed to -150, thereby simulating extreme superrefraction approaching ducting. In this case it is apparent that little change has taken place at short distances from the site, while more significant changes occur at greater distances. This, of course, is exactly what should be happening since the propagation of waves at short ranges is well approximated by a flat earth model (dN/dh = -156). It is only at somewhat greater distances that the effects of refraction begin to alter the radar propagation significantly. This further reinforces the idea that terrain masking is in large part a function of the characteristics of the terrain and is only modified by refraction.

5. Strike Altitudes

The last set of examples shows the effect of changing the AGL and MSL strike altitudes. The baseline case for the AGL displays is Figure 5.13, in which an AGL strike altitude of 200 feet is used. Figure 5.19 shows the same situation except that the AGL altitude is set at 600 feet. The first impression made by the comparison is that both masking envelopes

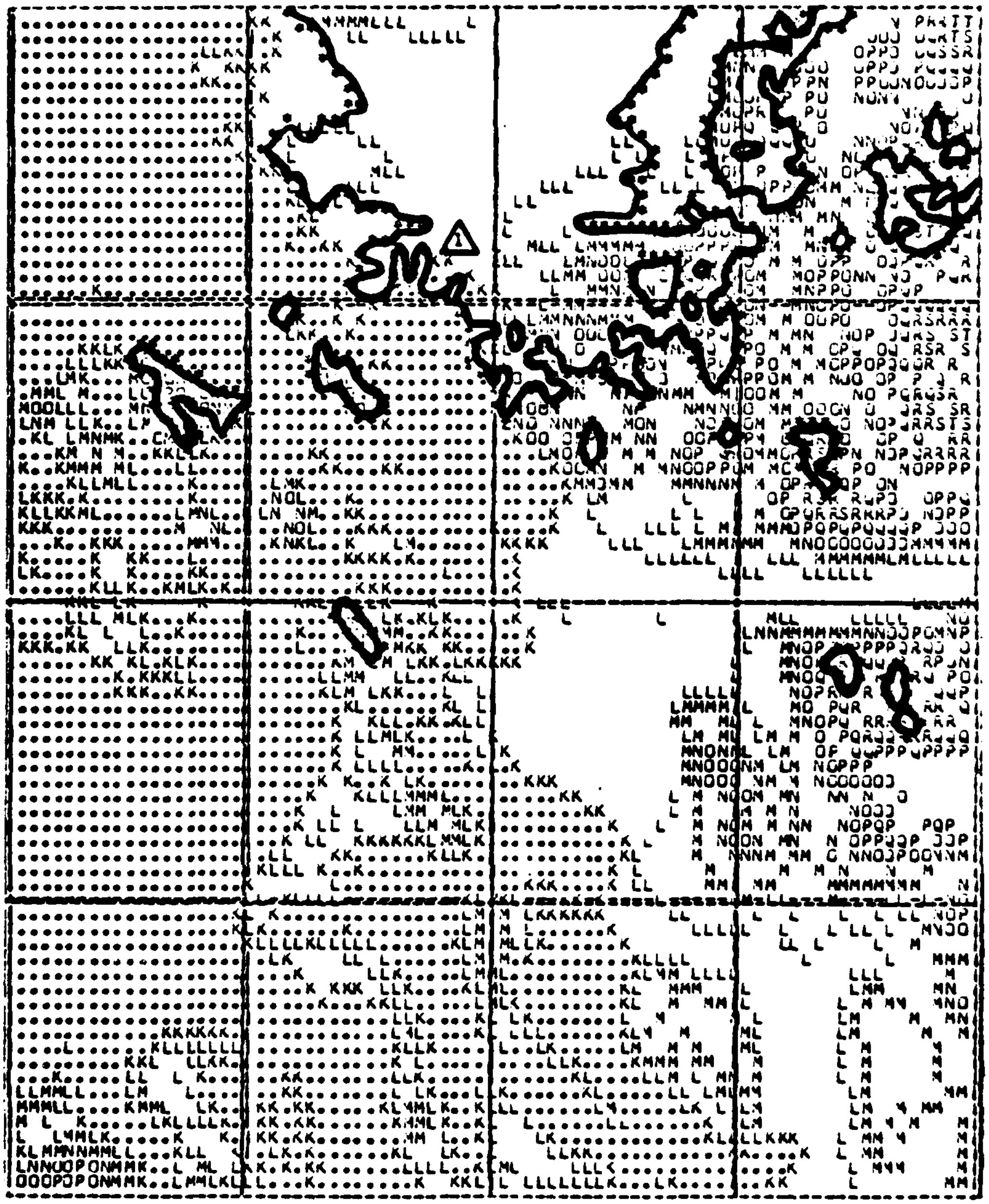


Figure 5.17 Optical Refraction Examples

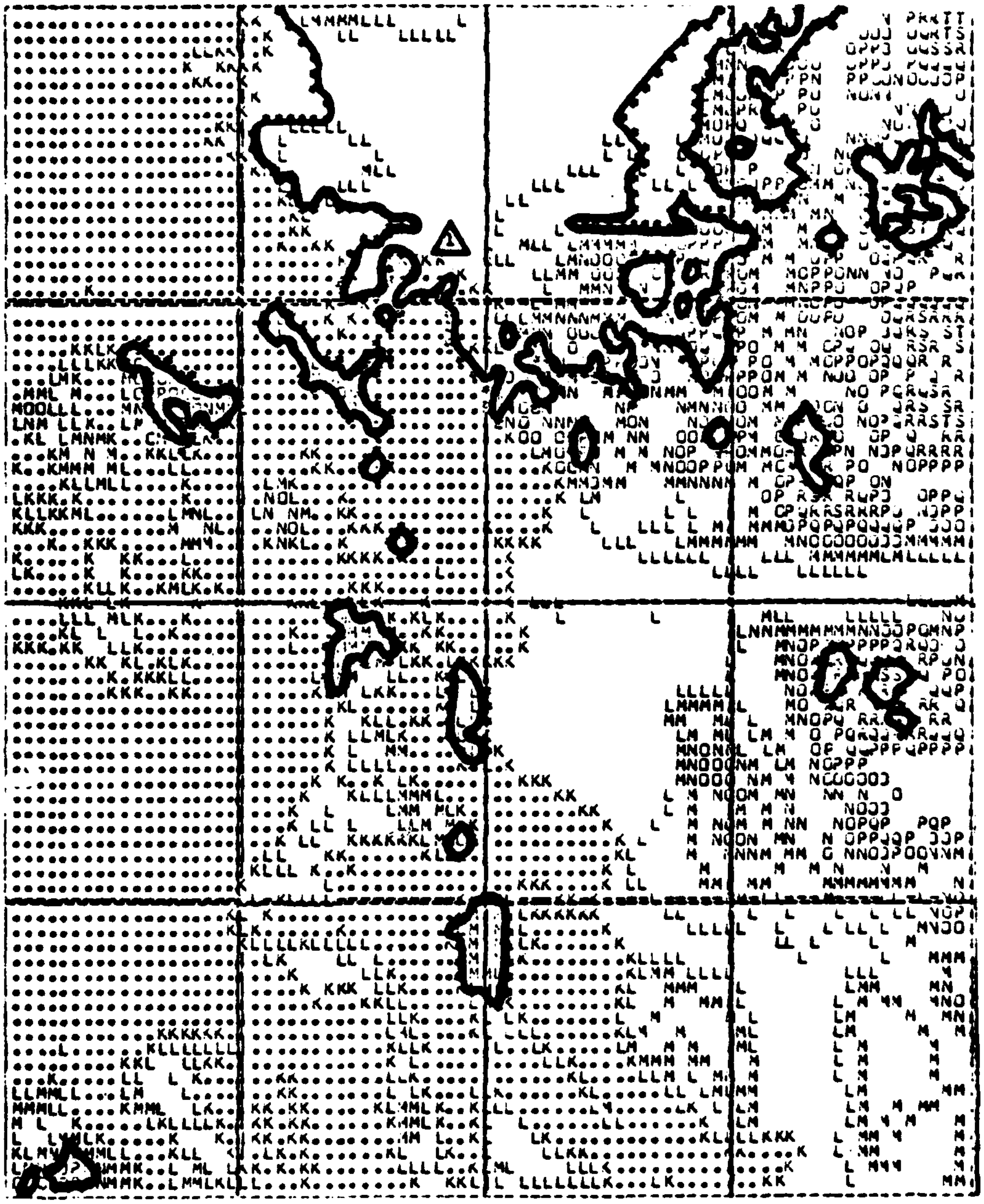


Figure 5.18 Superrefractive Gradient Example

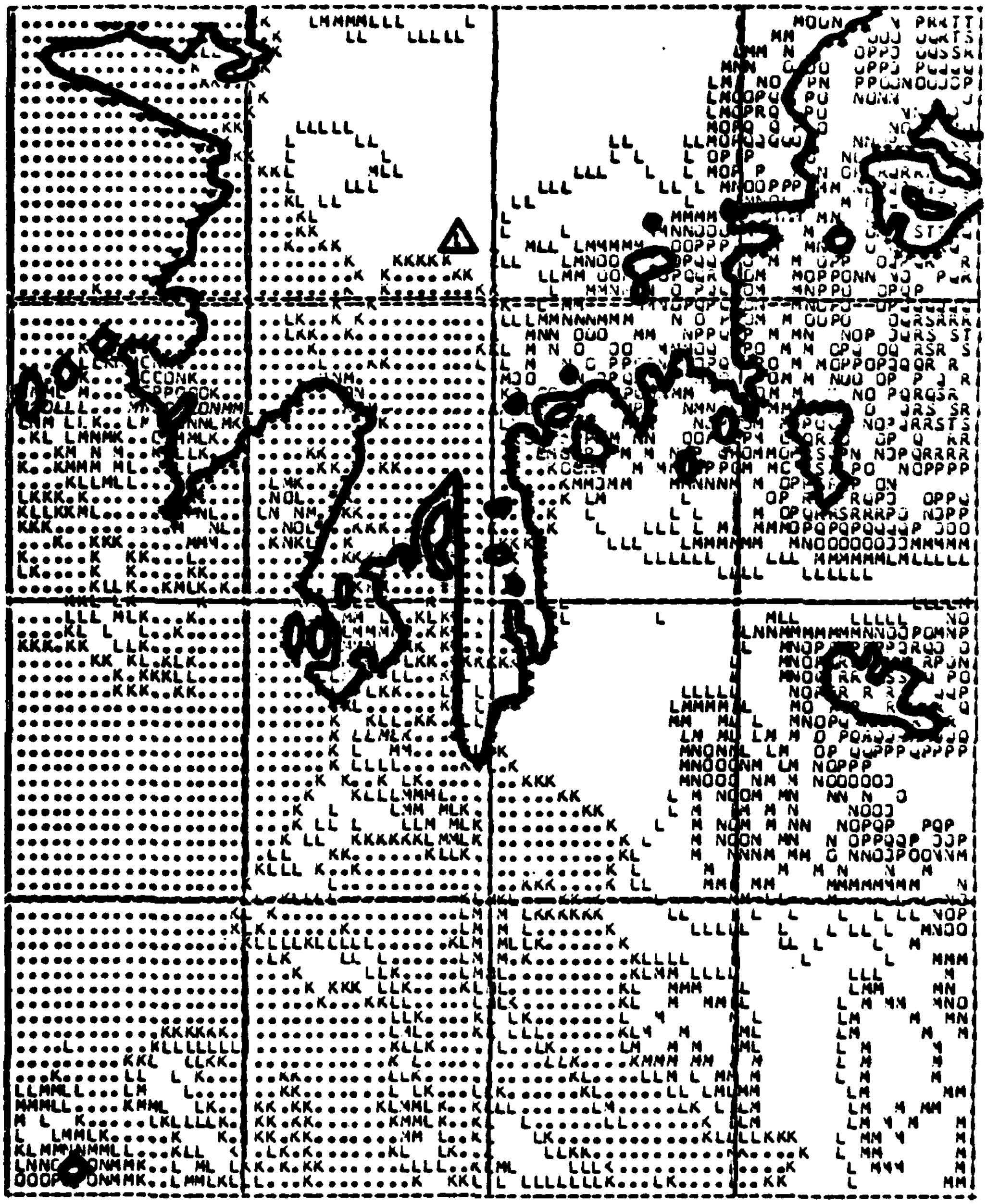


Figure 5.19 600 Foot AGL Strike Example

have the same general shape and the major difference is that the 600 AGL example envelope is larger. The same terrain features caused both envelopes so this development is not so unexpected. Perhaps the most significant result of this comparison is that some areas of the masking envelopes have not changed appreciably. This is especially evident in the area to the southeast of the site. This particular finding is in agreement with the earlier observation that the terrain to the southeast of the EW site was a major obstruction to the radar's coverage.

The comparison of MSL altitudes is illustrated in Figures 5.20 and 5.21. These two examples use radar and refractive inputs identical to those in Figure 5.14. The displayed area is 2 by 2 degrees which allows an additional comparison with Figure 5.12 which is the MSL display from the last run in the hypothetical strike example. Figure 5.20 uses an altitude of 5000 feet MSL resulting in a noticeable reduction in the coverage afforded in the 7000 MSL case. The appearance of a large number of '0' symbols in the southeast of the display indicates the existence of terrain in this area exceeding 5000 feet MSL. Figure 5.21 uses an altitude of 2000 MSL. The trend indicated in Figure 5.20 continues as the converage envelope shrinks toward the EW site and more '0' symbols are formed where the terrain exceeds 2000 feet MSL. By using Figures 5.12, 5.20 and 5.21, it is possible to determine points along the route of flight of the bomber element at which the aircraft must descend to remain masked. Figure 5.21 shows clearly that the aircraft need not descent below 2000 MSL during most of the transit to and from the target area.

These examples have by no means covered all of the possible combinations of effects which can be processed by MASK. However, they do

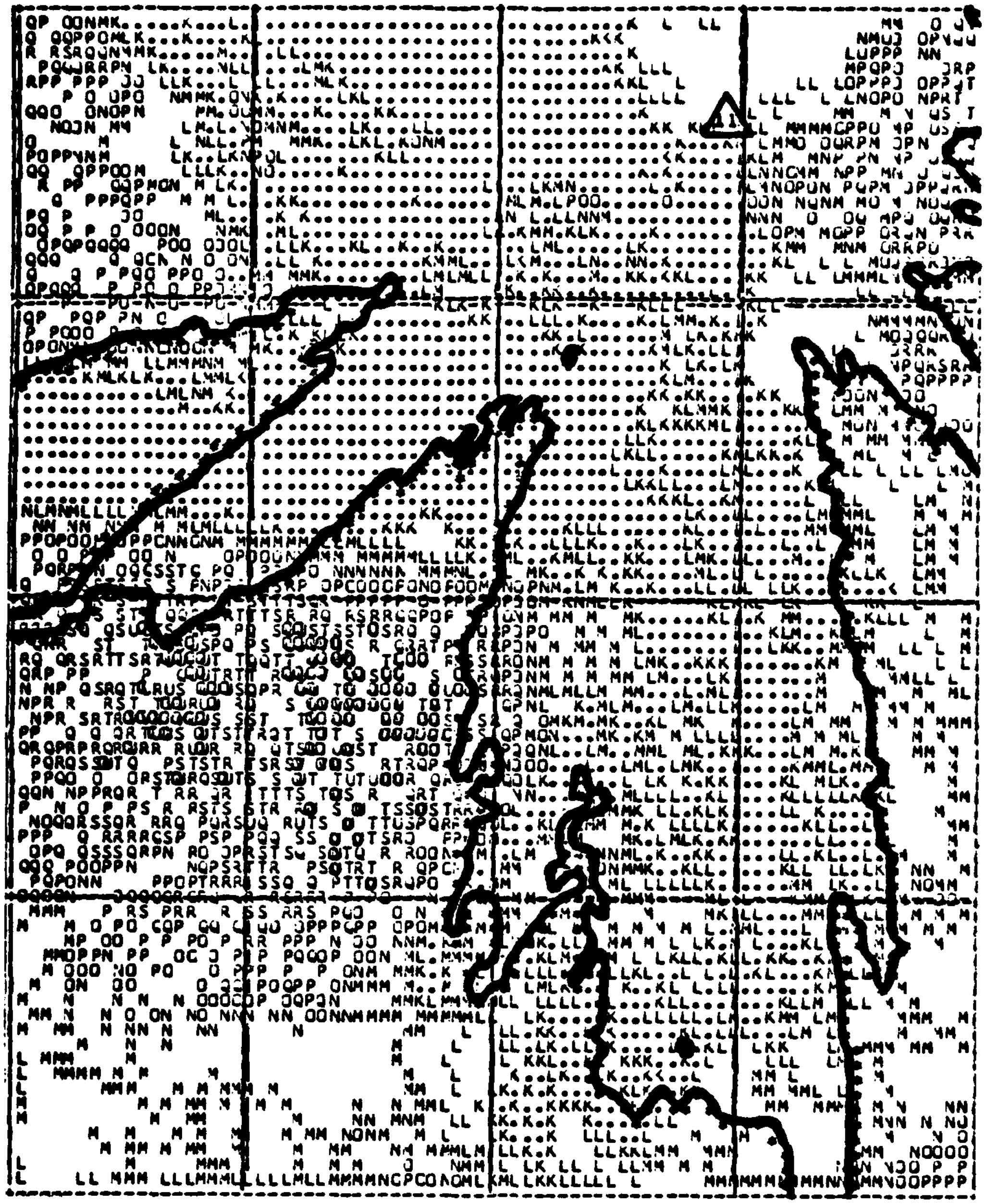


Figure 5.20 5000 Foot MSL Strike Example

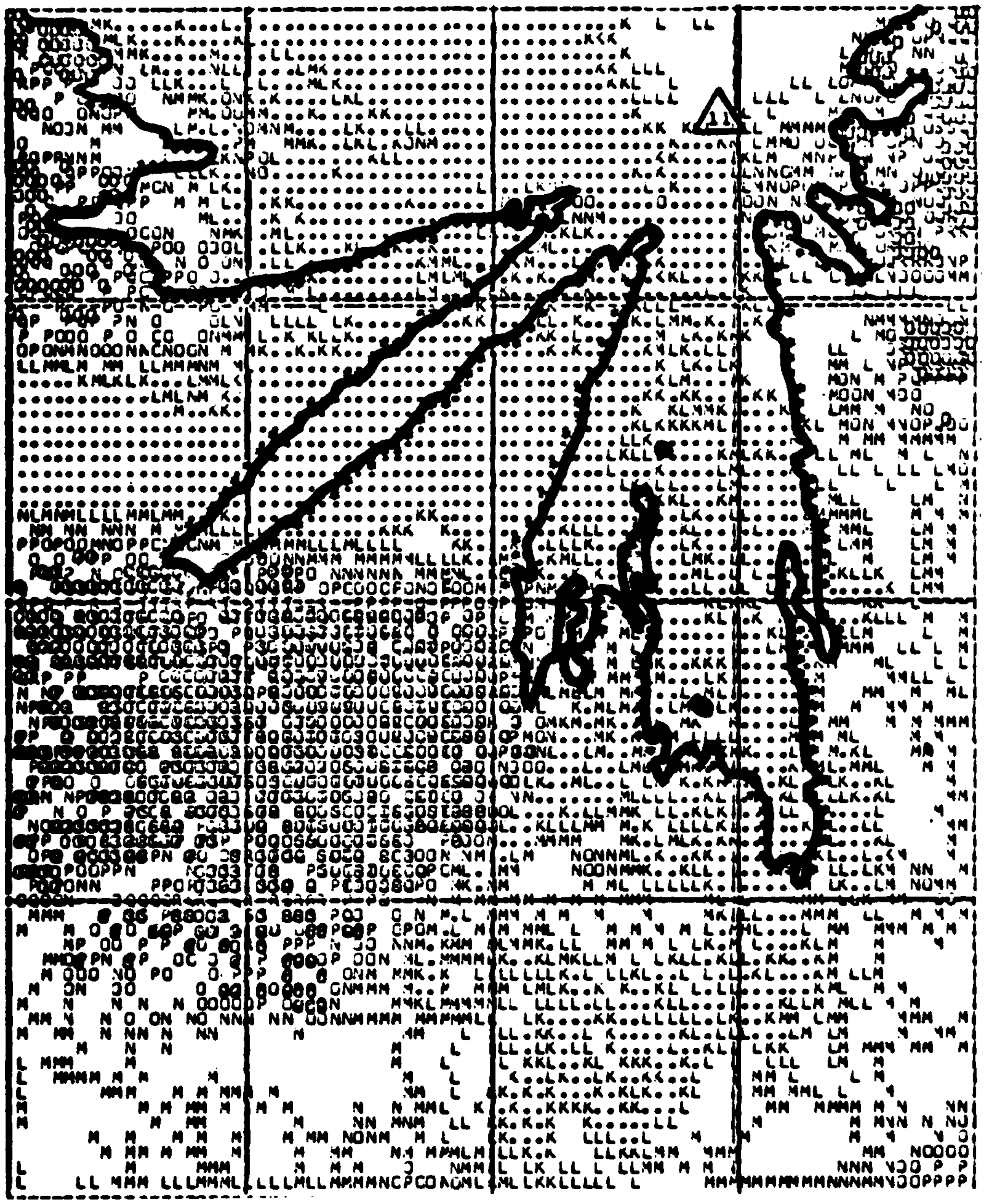


Figure 5.21 2000 Foot MSL Example

illustrate some of the more important changes brought about by altering the input values used in MASK.

VI. CONCLUSIONS AND RECOMMENDATIONS

MASK was developed as a thesis project. As a result, the programming expertise brought to bear on the subject was necessarily limited. The author makes no apology for this but recognizes it as a fact. More efficient programming methods are, no doubt, available for processing the data used in the masking calculations. In particular, the tedious means of combining several DTED files for large area coverage needs to be streamlined. This and other program refinements could easily occupy a student in pursuit of a thesis topic.

Additional recommendations are dependent on the final selection of a standard shipboard general purpose digital computer. Although the HP 9000 appears to be the current favorite, this is by no means a certainty. Depending on which system is ultimately procured a number of steps must be accomplished to implement MASK aboard ship. The source code must be translated if the shipboard computer cannot use FORTRAN. At a minimum in the case of the HP 9000, the program must be slightly modified to conform to the UNIX operating system. This can be done at the Naval Postgraduate School using the VAX system already installed in Spanagel Hall.

Additional work needs to be done on the graphic displays. The displays created for MASK were designed to be printed using only a line printer without any exotic graphics capability. The newer systems available have various graphics capabilities which would improve the clarity of the MASK displays and eliminate manual operations such as tracing envelopes onto the topographic displays. The output generating code will,

of necessity, require extensive modification depending on the particular system procured by the Navy. This is another area for consideration as a thesis topic in computer science.

Finally, some systems must be developed to supply user organizations with the required data bases, either in an already transformed status or as raw DTED tape files. The capability now exists at NPS to perform the required data base transformations, but the same programs are not likely to be compatible with smaller systems.

Given that the steps mentioned above are taken, MASK has the capability to significantly upgrade the effectiveness of the Navy's tactical air striking forces. Installed on each CV, MASK will allow the strike mission planner to more easily devise routes of flight to reduce the susceptibility of attacking forces to enemy air defenses. MASK will provide the capability to respond to urgent tasking in a timely manner without sacrificing the accuracy required to perform thorough preflight mission planning. The end result will be a greater probability of survival for our attacking aircraft and a consequent increase in the weight of ordnance delivered to the target. On an equal cost basis, it is unlikely that any other single improvement can increase the effectiveness of sea based air power more than the introduction of computer aided mission planning tools such as MASK.

Mention has already been made of the applicability of MASK to the air defense planning problem. In particular, Marine Corps air defense network planners could use MASK to compare alternative missile battery deployment patterns prior to landing the assets ashore. This capability would speed the establishment of organic area air defenses and could additionally be used to plan for contingency redeployment of air defense assets in case some of the systems were destroyed or rendered inoperative.

Additional applications of MASK in the areas of electronic warfare, airborne early warning, remotely piloted drone control and communications planning are numerous. The salient point is that MASK can fulfill an outstanding operational requirement to upgrade shipboard mission planning capabilities in order to meet an ever increasing air defense threat. Ignoring this requirement serves only to limit the effectiveness of the Navy's tactical air forces.

APPENDIX A

SOURCE CODE LISTING

The programs contained in this appendix are listed in the order in which they would normally be used in executing MASK. For example, the PROFILE EXEC is listed first followed by the FLY EXEC and then by the tape transfer programs and so on.

```
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCPRO00010
C    THIS IS THE 'PROFILE' EXEC.  IT PERFORMS FUNCTIONS RELATED TO MASK CPRO00020
C SUCH AS DEFINING TEMPORARY DISK SPACE AND DEFINING THE FILES WHICH    CPRO00030
C ARE USED TO MOVE DATA FROM TAPE TO MVS AND FROM MVS TO THE TEMPORARY CPRO00040
C DISK.  IT ALSO PERFORMS STANDARD LINKING TO FORTRAN LIBRARIES.       CPRO00050
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCPRO00060
&TRACE                                                                  PRO00070
CP TERMINAL LINESIZE 80                                                 PRO00080
GLOBAL TXTLIB FORTMOD2 MOD2EEH NONIMSL IMSLSP                           PRO00090
SET BLIP CRANKING                                                       PRO00100
GLOBAL MACLIB WATLIB IMSLDP                                             PRO00110
EXEC ON                                                                 PRO00120
FILEDEF INMOVE C1 DSN S1086 DATA(PERM RECFM FB BLKSIZE 12070 LRECL 2414 PRO00130
FILEDEF OUTMOVE DISK TAPE DATA D1(PERM RECFM FB BLKSIZE 12070 LRECL 2414PRO00140
CP DEFINE T3350 AS 200 CYL 20                                           PRO00150
FORMAT 200 D                                                            PRO00160
&BEGTYPE                                                                PRO00170
&END                                                                    PRO00180
```

```
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C    THIS IS THE 'FLY' EXEC.  ITS FUNCTION IS TO COMPILE, LOAD AND RUN  C
C VARIOUS PROGRAMS INCLUDING 'TERR', 'MASK', 'COMBIN' AND 'TRANS'.  IN C
C ADDITION, SEVERAL FILES ARE DEFINED.  FILE 04 IS USED FOR INPUT TO   C
C 'MASK', FILE 05 IS A GENERAL INTERACTIVE I/O FILE AND FILE 06 IS A   C
C GENERAL OUTPUT FILE. FILE 08 IS THE OUTPUT FILE FOR 'TRANS' AND 'COM-C
C BIN', FILE 09 IS THE INPUT FILE FOR 'TRANS' AND FILE 10 IS THE TEMPO-C
C RARY HOLDING FILE USED BY 'TRANS' DURING TRANSFORMATIONS OF DATA AT  C
C HIGH LATITUDES.  FILES 11-55 ARE 'COMBIN' INPUT FILES.  THE COMMAND C
C USED TO RUN ANY GIVEN PROGRAM 'XXX' IS 'FLY XXX'.
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
&TRACE ALL
FORTHX &1 (GOSTMT
ERASE &1 LISTING
FILEDEF 04 DISK &1 DATA D1 (PERM)
FILEDEF 05 TERMINAL (PERM)
FILEDEF 06 DISK &1 OUT D1(PERM)
FILEDEF 08 DISK MASK DATA D1(PERM LRECL 80 BLKSIZE 80 RECFM FB)
FILEDEF 09 DISK TAPE DATA D1(PERM LRECL 2414 BLKSIZE 12070 RECFM FB)
FILEDEF 10 DISK TEMP DATA D1(PERM LRECL 2414 BLKSIZE 12070 RECFM FB)
FILEDEF 11 DISK M4812418 DATA D1(PERM)
FILEDEF 12 DISK M4812318 DATA D1(PERM)
FILEDEF 13 DISK M4712418 DATA D1(PERM)
FILEDEF 14 DISK M4712318 DATA D1(PERM)
FILEDEF 15 DISK M4912236 DATA D1(PERM)
FILEDEF 16 DISK M4912136 DATA D1(PERM)
FILEDEF 17 DISK M4912036 DATA D1(PERM)
FILEDEF 18 DISK M4911936 DATA D1(PERM)
FILEDEF 19 DISK M4812236 DATA D1(PERM)
FILEDEF 20 DISK M4812136 DATA D1(PERM)
FILEDEF 21 DISK M4812036 DATA D1(PERM)
FILEDEF 22 DISK M4811936 DATA D1(PERM)
FILEDEF 23 DISK M4712236 DATA D1(PERM)
FILEDEF 24 DISK M4712136 DATA D1(PERM)
FILEDEF 25 DISK M4712036 DATA D1(PERM)
FILEDEF 26 DISK M4711936 DATA D1(PERM)
FILEDEF 27 DISK M4612236 DATA D1(PERM)
FILEDEF 28 DISK M4612136 DATA D1(PERM)
FILEDEF 29 DISK M4612036 DATA D1(PERM)
FILEDEF 30 DISK M4611936 DATA D1(PERM)
FILEDEF 31 DISK M5012345 DATA A1(PERM)
FILEDEF 32 DISK M5012245 DATA A1(PERM)
FILEDEF 33 DISK M5012145 DATA A1(PERM)
FILEDEF 34 DISK M5012045 DATA A1(PERM)
FILEDEF 35 DISK M5011945 DATA A1(PERM)
FILEDEF 36 DISK M4912345 DATA A1(PERM)
FILEDEF 37 DISK M4912245 DATA A1(PERM)
FILEDEF 38 DISK M4912145 DATA A1(PERM)
```

```
FILEDEF 39 DISK M4912045 DATA A1(PERM)
FILEDEF 40 DISK M4911945 DATA A1(PERM)
FILEDEF 41 DISK M4812345 DATA A1(PERM)
FILEDEF 42 DISK M4812245 DATA A1(PERM)
FILEDEF 43 DISK M4812145 DATA A1(PERM)
FILEDEF 44 DISK M4812045 DATA A1(PERM)
FILEDEF 45 DISK M4811945 DATA A1(PERM)
FILEDEF 46 DISK M4712345 DATA A1(PERM)
FILEDEF 47 DISK M4712245 DATA A1(PERM)
FILEDEF 48 DISK M4712145 DATA A1(PERM)
FILEDEF 49 DISK M4712045 DATA A1(PERM)
FILEDEF 50 DISK M4711945 DATA A1(PERM)
FILEDEF 51 DISK M4612345 DATA A1(PERM)
FILEDEF 52 DISK M4612245 DATA A1(PERM)
FILEDEF 53 DISK M4612145 DATA A1(PERM)
FILEDEF 54 DISK M4612045 DATA A1(PERM)
FILEDEF 55 DISK M4611945 DATA A1(PERM)
LOAD &1
START
ERASE &1 TEXT
ERASE TEMP DATA D1
```

```
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCTSC00010
C    THIS IS THE 'TSCN' JCL PROGRAM.  IT ACCESSES A  GIVEN TAPE VOLUME  CTSC00020
C AND READS A 'TABLE OF CONTENTS' FOR THE TAPE.                         CTSC00030
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCTSC00040
//MCKI1086 JOB (1086,0031),'MCKINNEY',CLASS=E                           TSC00050
//*MAIN ORG=NPGVM1.1086P                                                TSC00060
//     EXEC TSCAN,VOLIN=S798,DCBIN='DEN=3',UNITIN='3400-3'              TSC00070
/*                                                                      TSC00080
//                                                                      TSC00090
```

```
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C   THIS IS THE 'GETTAPE' JCL PROGRAM.  IT ACCESSES A GIVEN TAPE VOLUME C
C AND FILE AND TRANSFERS IT TO MVS004.                                   C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
//GETTAPE JOB (1086,0001),'MCKINNEY',CLASS=E
//*MAIN ORG=NPGVM1.1086P
//   EXEC PGM=IEBGENER
//SYSPRINT DD SYSOUT=A
//SYSUT1  DD  DISP=OLD,UNIT=3400-3,VOL=SER=S796,
//            DSNAME=DMA.DATA,LABEL=(05,BLP),
//            DCB=(RECFM=F,BLKSIZE=2414,DEN=3)
//SYSUT2  DD  DISP=(NEW,KEEP),UNIT=3350,VOL=SER=MVS004,
//            DSNAME=S1086.DATA,SPACE=(12070,(1204,0)),
//            DCB=(RECFM=FB,BLKSIZE=12070,LRECL=2414)
//SYSIN   DD   *
/*
```

```
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C     THIS IS THE 'TERR' PROGRAM.  IT CREATES A TEST TERRAIN DATA BASE  C
C WHICH IS USED BY 'MASK' FOR TEST PURPOSES.  THE TRANSFORMATION         C
C INTERVAL, SOUTHWEST CORNER LOCATION AND PYRAMID HEIGHT MULTIPLIER     C
C MAY BE CHANGED TO SUIT THE NEEDS OF THE USER.  THE PROGRAM IS EXECU- C
C TED BY ISSUING THE COMMAND 'FLY TERR'.  OUTPUT IS DIRECTED TO THE     C
C 'MASK DATA D1' FILE ON THE TEMPORARY DISK.                            C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C                                                                      C
C       VARIABLE LISTING                                               C
C                                                                      C
C       NAME   TYPE                   FUNCTION                         C
C                                                                      C
C       A        I     INDEX  VARIABLE FOR ROWS                        C
C       B        I     INDEX  VARIABLE FOR COLUMNS                     C
C       I        I     INDEX  VARIABLE FOR ROWS                        C
C       J        I     INDEX  VARIABLE FOR COLUMNS                     C
C       M        I     INDEX  VARIABLE FOR ROWS                        C
C       N        I     INDEX  VARIABLE FOR COLUMNS                     C
C       T        I**2 OUTPUT DATA MATRIX
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      INTEGER I,J,M,N,A,B
      INTEGER*2    T(400,400)
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C    INITIALIZE DATA MATRIX AT SEA LEVEL                               C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      DO 10 A=1,400
         DO 20 B=1,400
               T(A,B)=0
 20      CONTINUE
 10   CONTINUE
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C    CREATE THE NORTHWEST PYRAMID                                      C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      DO 30 I=101,150
         DO 40 J=101,150
               T(I,J)=((I-101)*(J-101))/50
 40      CONTINUE
 30   CONTINUE
      DO 50 M=101,150
         DO 60 J=151,200
               T(M,J)=((M-101)*(200-J))/50
 60      CONTINUE
 50   CONTINUE
      DO 70 I=151,200
         DO 80 N=101,150
               T(I,N)=((200-I)*(N-101))/50
 80      CONTINUE
```

```
70    CONTINUE                                                          TER00490
      DO 90 M=151,200                                                   TER00500
        DO 100 N=151,200                                                TER00510
          T(M,N)=((200-M)*(200-N))/50                                   TER00520
100     CONTINUE                                                        TER00530
90    CONTINUE                                                          TER00540
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCTER00550
C   CREATE THE NORTHEAST PYRAMID                                       CTER00560
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCTER00570
      DO 110 I=201,250                                                  TER00580
        DO 120 J=101,150                                                TER00590
          T(I,J)=((I-201)*(J-101))/25                                   TER00600
120     CONTINUE                                                        TER00610
110   CONTINUE                                                          TER00620
      DO 130 M=201,250                                                  TER00630
        DO 140 J=151,200                                                TER00640
          T(M,J)=((M-201)*(200-J))/25                                   TER00650
140     CONTINUE                                                        TER00660
130   CONTINUE                                                          TER00670
      DO 150 I=251,300                                                  TER00680
        DO 160 N=101,150                                                TER00690
          T(I,N)=((300-I)*(N-101))/25                                   TER00700
160     CONTINUE                                                        TER00710
150   CONTINUE                                                          TER00720
      DO 170 M=251,300                                                  TER00730
        DO 180 N=151,200                                                TER00740
          T(M,N)=((300-M)*(200-N))/25                                   TER00750
180     CONTINUE                                                        TER00760
170   CONTINUE                                                          TER00770
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC TER00780
C   CREATE THE SOUTHEAST PYRAMID                                      C TER00790
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC TER00800
      DO 190 I=301,350                                                  TER00810
        DO 200 J=201,250                                                TER00820
          T(I,J)=((I-301)*(J-201))/100                                  TER00830
200     CONTINUE                                                        TER00840
190   CONTINUE                                                          TER00850
      DO 210 M=301,350                                                  TER00860
        DO 220 J=251,300                                                TER00870
          T(M,J)=((M-301)*(300-J))/100                                  TER00880
220     CONTINUE                                                        TER00890
210   CONTINUE                                                          TER00900
      DO 230 I=351,400                                                  TER00910
        DO 240 N=201,250                                                TER00920
          T(I,N)=((400-I)*(N-201))/100                                  TER00930
240     CONTINUE                                                        TER00940
230   CONTINUE                                                          TER00950
      DO 250 M=351,400                                                  TER00960
```

```
      DO 260 N=251,300
         T(M,N)=((400-M)*(300-N))/100                                   TER00970
  260    CONTINUE                                                       TER00980
  250 CONTINUE                                                          TER00990
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCTER01000
C     WRITE THE TRANSFORMATION INTERVAL AND SOUTHWEST CORNER LOCATION   CTER01010
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCTER01020
      WRITE(8,699)                                                      TER01030
  699 FORMAT('06',78X)                                                  TER01040
      WRITE(8,700)                                                      TER01050
  700 FORMAT('W',79X)                                                   TER01060
      WRITE(8,710)                                                      TER01070
  710 FORMAT('1230000 1230000',65X)                                     TER01080
      WRITE(8,720)                                                      TER01090
  720 FORMAT('NN',78X)                                                  TER01100
      WRITE(8,730)                                                      TER01110
  730 FORMAT('0460000 0460000',65X)                                     TER01120
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCTER01130
C     MULTIPLY EACH MATRIX ELEMENT BY A CONSTANT VALUE                  CTER01140
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCTER01150
      DO 500 I=1,400                                                    TER01160
         DO 510 J=1,400                                                 TER01170
            T(I,J)=T(I,J)*10                                            TER01180
  510    CONTINUE                                                       TER01190
  500 CONTINUE                                                          TER01200
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCTER01210
C     OUTPUT THE DATA MATRIX TO THE MASK DATA D1 FILE                   CTER01220
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCTER01230
      DO 520 I=1,400                                                    TER01240
         WRITE(8,600)(T(I,J),J=1,400)                                   TER01250
  600    FORMAT(40A2)                                                   TER01260
  520 CONTINUE                                                          TER01270
      STOP                                                              TER01280
      END                                                               TER01290
                                                                        TER01300
```

```
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C     THIS IS THE 'TRANS' PROGRAM.  IT ACCEPTS THE DTED DATA BASE ONE     C
C LINE AT A TIME AND TRANSFORMS THE DATA INTO A FORM ACCEPTABLE TO        C
C EITHER MASK OR COMBIN.                                                   C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C                                                                          C
C        VARIABLE LISTING                                                  C
C                                                                          C
C        NAME   TYPE                    FUNCTION                           C
C                                                                          C
C        A      I**2 INPUT VECTOR CONTAINING ONE LINE OF DTED DATA         C
C        DBINT   I   DTED DATA BASE LONGITUDE INTERVAL                     C
C        DLAT    I   LATITUDE OF OUTPUT DATA BASE SOUTHWEST CORNER         C
C        DLON    I   LONGITUDE OF OUTPUT DATA BASE SOUTHWEST CORNER        C
C        E       I   EAST                                                  C
C        EW      I   VARIABLE TAKING VALUE 'EAST' OR 'NOT EAST'            C
C        GLAT    I   LATITUDE OF DTED DATA BASE SOUTHWEST CORNER           C
C        GLON    I   LONGITUDE OF DTED DATA BASE SOUTHWEST CORNER          C
C        I       I   INDEX VARIABLE FOR ROWS                               C
C        IFIN    I   ROW NUMBER AT END OF TRANSFORMATION                   C
C        IMAX    I   NUMBER OF ROWS TO BE TRANSFORMED                      C
C        INIT    I   ROW NUMBER AT START OF TRANSFORMATION                 C
C        INTVL   I   OUTPUT TRANSFORMATION INTERVAL                        C
C        J       I   INDEX VARIABLE FOR COLUMNS                            C
C        JINIT   I   COLUMN NUMBER AT START OF TRANSFORMATION              C
C        JFIN    I   COLUMN NUMBER AT END OF TRANSFORMATION                C
C        JMAX    I   NUMBER OF COLUMNS TO BE TRANSFORMED                   C
C        KMAX    I   ROW LENGTH OF DTED DATA BASE                          C
C        LMAX    I   NUMBER OF DUPLICATE RECORDS PER COLUMN OF DTED        C
C        MINUS   I   JINIT MINUS ONE                                       C
C        NN      I   NORTH                                                 C
C        NS      I   VARIABLE TAKING VALUES 'NORTH' OR 'NOT NORTH'         C
C        SK      I   NUMBER OF DTED DATA POINTS DELETED PER ROW OR COL     C
C        SSK     I   FUNCTION OF 'SK'                                      C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      INTEGER*2     A(1207)
      INTEGER I,J,IMAX,JMAX,EW,NS,GLON,GLAT,SSK,KMAX,LMAX
      INTEGER SK,CLAT,DLON,DBINT,INTVL,INIT,JINIT,IFIN,JFIN,MINUS
      INTEGER NN/'NN'/,E/'E'/
      WRITE(5,100)
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C     INPUT DTED S.W. CORNER LOCATION, DESIRED DATA BASE S.W. LOCATION,   C
C AND TRANSFORMATION INTERVAL                                              C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
  100 FORMAT(1X,'ENTER DESIRED INTERVAL FOR TRANSFORMED DATA BASE IN COL
     *UMNS 1-2'/' THIS WILL EQUAL THE NUMBER OF ARC SECONDS BETWEEN ELEV
     *ATION DATA'/' POINTS IN THE TERRAIN GRID.  PERMISSABLE VALUES ARE
     *03,06,09,18,36 AND 45.'/'  THESE VALUES WILL PRODUCE,RESPECTIVELY,
```

```
     * SQUARE DATA BASES WITH THE'/'  FOLLOWING DIMENSIONS IN MINUTES: 2TRA00490
     *0,40,60,120,240,300.')                                            TRA00500
      READ(5,110) INTVL                                                 TRA00510
110   FORMAT(I2)                                                        TRA00520
      WRITE(5,120)                                                      TRA00530
120   FORMAT(' ENTER THE LATITUDE AND LONGITUDE OF THE SOUTHWEST CORNER TRA00540
     *OF THE INPUT DMAAC'/' DATA BASE IN THE FOLLOWING FORMAT:NN OR SS  TRA00550
     +IN COLUMNS 1-2 DEPENDING ON WHETHER'/' THE CORNER IS ABOVE OR BELOTRA00560
     *W THE EQUATOR.')                                                  TRA00570
      READ(5,130) NS                                                    TRA00580
130   FORMAT(A2)                                                        TRA00590
      WRITE(5,140)                                                      TRA00600
140   FORMAT(' NOW ENTER THE LATITUDE (DDDMMSS) IN COLUMNS 1-7.')       TRA00610
      READ(5,150) GLAT                                                  TRA00620
150   FORMAT(I7)                                                        TRA00630
      WRITE(5,160)                                                      TRA00640
160   FORMAT(' NOW ENTER E OR W IN COLUMN 1 DEPENDING ON WHETHER THE CORTRA00650
     *NER IS EAST'/' OR WEST OF 0 DEGREES LONGITUDE.')                  TRA00660
      READ(5,170) EW                                                    TRA00670
170   FORMAT(A1)                                                        TRA00680
      WRITE(5,180)                                                      TRA00690
180   FORMAT(' NOW ENTER THE LONGITUDE (DDDMMSS) IN COLUMNS 1-7.')      TRA00700
      READ(5,190) GLON                                                  TRA00710
190   FORMAT(I7)                                                        TRA00720
      WRITE(5,191)                                                      TRA00730
191   FORMAT(' NOW ENTER THE LATITUDE OF THE SOUTHWEST CORNER OF THE ARETRA00740
     *A TO BE'/' TRANSFORMED (DDDMMSS) IN COLUMNS 1-7.')                TRA00750
      READ(5,192) DLAT                                                  TRA00760
192   FORMAT(I7)                                                        TRA00770
      WRITE(5,193)                                                      TRA00780
193   FORMAT(' NOW ENTER THE LONGITUDE OF THE SOUTHWEST CORNER OF THE ARTRA00790
     *EA TO BE'/' TRANSFORMED (DDDMMSS) IN COLUMNS 1-7.')               TRA00800
      READ(5,194) DLON                                                  TRA00810
194   FORMAT(I7)                                                        TRA00820
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCTRA00830
C     FOR LATITUDES LESS THAN 50 DEGREES DTED INTERVAL IS THREE        CTRA00840
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCTRA00850
      IF((NS.EQ.NN.AND.GLAT/10000.GE.50).OR.(NS.NE.NN.AND.GLAT/10000.GE.TRA00860
     *51)) GO TO 10                                                     TRA00870
         DBINT=3                                                        TRA00880
         GO TO 30                                                       TRA00890
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCTRA00900
C     FOR LATITUDES FROM 50 TO 75, DTED INTERVAL IS SIX                CTRA00910
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCTRA00920
10    IF((NS.EQ.NN.AND.GLAT/10000.GE.75).OR.(NS.NE.NN.AND.GLAT/10000.GE.TRA00930
     *76)) GO TO 25                                                     TRA00940
         DBINT=6                                                        TRA00950
         GO TO 30                                                       TRA00960
```

```
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCTRA00970
C     ABOVE 75 DEGREES, DTED INTERVAL IS TWELVE                         CTRA00980
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCTRA00990
25    DBINT=12                                                           TRA01000
30    CONTINUE                                                           TRA01010
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCTRA01020
C     DEPENDING ON HEMISPHERE OF LONGITUDE, COMPUTE BEGINNING COLUMN    CTRA01030
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCTRA01040
      IF(EW.NE.E) GO TO 40                                               TRA01050
         JINIT=IRND(FLOAT(IASEC(DLON)-IASEC(GLON))/FLOAT(DBINT))+1       TRA01060
         GO TO 50                                                        TRA01070
40    JINIT=IRND(FLOAT(IASEC(GLON)-IASEC(DLON))/FLOAT(DBINT))+1          TRA01080
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCTRA01090
C     DEPENDING ON HEMISPHERE OF LATITUDE, COMPUTE ENDING ROW           CTRA01100
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCTRA01110
50    IF(NS.NE.NN) GO TO 60                                              TRA01120
         IFIN=1200-IRND(FLOAT(IASEC(DLAT)-IASEC(GLAT))/3.0)              TRA01130
         GO TO 70                                                        TRA01140
60    IFIN=1200-IRND(FLOAT(IASEC(GLAT)-IASEC(DLAT))/3.0)                 TRA01150
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCTRA01160
C     COMPUTE NUMBER OF ROWS AND COLUMNS TO BE TRANSFORMED              CTRA01170
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCTRA01180
70    IMAX=MINO(1200,(INTVL/3)*400)-1                                    TRA01190
      JMAX=MINO(400,(3600/INTVL))                                        TRA01200
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCTRA01210
C   DETERMINE NUMBER OF DATA POINTS TO BE DELETED DURING TRANSFORMATION CTRA01220
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCTRA01230
      SK=INTVL/3                                                         TRA01240
      IF(SK.EQ.1) SSK=1                                                  TRA01250
      IF(SK.EQ.2) SSK=2                                                  TRA01260
      IF(SK.EQ.3) SSK=3                                                  TRA01270
      IF(SK.EQ.6) SSK=4                                                  TRA01280
      IF(SK.EQ.12)SSK=5                                                  TRA01290
      IF(SK.EQ.15)SSK=6                                                  TRA01300
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCTRA01310
C     COMPUTE BEGINNING ROW OF TRANSFORMATION                           CTRA01320
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCTRA01330
      INIT=IFIN-IMAX                                                     TRA01340
      MINUS=JINIT-1                                                      TRA01350
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCTRA01360
C     WRITE OUTPUT DATA BASE HEADER                                     CTRA01370
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCTRA01380
      WRITE(8,200)INTVL                                                  TRA01390
 200  FORMAT(I2)                                                         TRA01400
      WRITE(8,210)EW                                                     TRA01410
 210  FORMAT(A1)                                                         TRA01420
      WRITE(8,220)GLON,DLON                                              TRA01430
 220  FORMAT(I7,1X,I7)                                                   TRA01440
```

```
      WRITE(8,230)NS                                                      TRA01450
230   FORMAT(A2)                                                          TRA01460
      WRITE(8,240)GLAT,DLAT                                               TRA01470
240   FORMAT(I7,1X,I7)                                                    TRA01480
      IF(DBINT.EQ.3) GO TO 85                                             TRA01490
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCTRA01500
C  IF DTED DATA IS FROM GREATER THAN 50 DEGREES, PAD USING DUPLICATION CTRA01510
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCTRA01520
         KMAX=3600/DBINT                                                  TRA01530
         LMAX=DBINT/3                                                     TRA01540
         DO 80 K=1,600                                                    TRA01550
              READ(9,250)(A(I),I=1,1200)                                  TRA01560
              DO 81 L=1,LMAX                                              TRA01570
                   WRITE(3,250)(A(I),I=1,1200)                            TRA01580
81            CONTINUE                                                    TRA01590
80       CONTINUE                                                         TRA01600
      IF(GLON.EQ.DLON) GO TO 82                                           TRA01610
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCTRA01620
C    DELETE ALL ROWS PRECEEDING FIRST ROW OF TRANSFORMATION              CTRA01630
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCTRA01640
         DO 83 J=1,MINUS                                                  TRA01650
              READ(10,245)                                                TRA01660
245           FORMAT(A2)                                                  TRA01670
83       CONTINUE                                                         TRA01680
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCTRA01690
C    READ AND WRITE ONE ROW AT A TIME, DELETING THE APPRORIATE NUMBER   CTRA01700
C OF DATA POINTS DURING THE PROCESS                                      CTRA01710
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCTRA01720
82    DO 84 J=1,JMAX                                                      TRA01730
          GO TO(1,2,3,6,12,15),SSK                                        TRA01740
1         READ(10,250)(A(1200-I+1),I=1,1200)                              TRA01750
250       FORMAT(8X,6(200A2))                                             TRA01760
          GO TO 21                                                        TRA01770
2         READ(10,260)(A(1200-I+1),I=1,1200)                              TRA01780
260       FORMAT(8X,6(200A2)/)                                            TRA01790
          GO TO 21                                                        TRA01800
3         READ(10,270)(A(1200-I+1),I=1,1200)                              TRA01810
270       FORMAT(8X,6(200A2)//)                                           TRA01820
          GO TO 21                                                        TRA01830
6         READ(10,280)(A(1200-I+1),I=1,1200)                              TRA01840
280       FORMAT(8X,6(200A2)/////)                                        TRA01850
          GO TO 21                                                        TRA01860
12        READ(10,290)(A(1200-I+1),I=1,1200)                              TRA01870
290       FORMAT(8X,6(200A2)///////////)                                  TRA01880
          GO TO 21                                                        TRA01890
15        READ(10,300)(A(1200-I+1),I=1,1200)                              TRA01900
300       FORMAT(8X,6(200A2)//////////////)                               TRA01910
21        WRITE(8,310,END=320)(A(I),I=INIT,IFIN,SK)                       TRA01920
```

```
310       FORMAT(40A2)                                                  TRA01930
 84   CONTINUE                                                          TRA01940
      GO TO 320                                                         TRA01950
 85   IF(GLON.EQ.CLON) GO TO 86                                         TRA01960
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCTRA01970
C    PERFORM IDENTICAL OPERATIONS IF DATA IS NCT TO BE PADDED          CTRA01980
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCTRA01990
         DO 87 J=1,MINUS                                                TRA02000
             READ(9,245)                                                TRA02010
 87      CONTINUE                                                       TRA02020
 86   DO 88 J=1,JMAX                                                    TRA02030
          GO TO(31,32,33,34,35,36),SSK                                  TRA02040
 31       READ(9,250)(A(1200-I+1),I=1,1200)                             TRA02050
          GO TO 37                                                      TRA02060
 32       READ(9,260)(A(1200-I+1),I=1,1200)                             TRA02070
          GO TO 37                                                      TRA02080
 33       READ(9,270)(A(1200-I+1),I=1,1200)                             TRA02090
          GO TO 37                                                      TRA02100
 34       READ(9,280)(A(1200-I+1),I=1,1200)                             TRA02110
          GO TO 37                                                      TRA02120
 35       READ(9,290)(A(1200-I+1),I=1,1200)                             TRA02130
          GO TO 37                                                      TRA02140
 36       READ(9,300)(A(1200-I+1),I=1,1200)                             TRA02150
 37       WRITE(8,310,END=320)(A(I),I=INIT,IFIN,SK)                     TRA02160
 88       CONTINUE                                                      TRA02170
320   WRITE(5,330)                                                      TRA02180
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCTRA02190
C    SEND COMPLETICN MESSAGE TO USER                                   CTRA02200
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCTRA02210
330   FORMAT(' TRANSFORMATION COMPLETE')                                TRA02220
      STOP                                                              TRA02230
      END                                                               TRA02240
```

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CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C   THIS IS THE 'COMBIN' PROGRAM.  IT ACCEPTS FILES OF TRANSFORMED DATA C
C  AND ASSEMBLES THEM TO FORM LARGE AREA AGGREGATE DATA BASES.  THE     C
C  OUTPUT FILE IS THE SAME FORMAT AS A NORMAL MASK DATA FILE.           C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C                                                                       C
C       VARIABLE LISTING                                                C
C                                                                       C
C       NAME     TYPE                  FUNCTION                         C
C                                                                       C
C       DLAT      I      LATITUDE OF S.W. CORNER OF OUTPUT DATA BASE    C
C       DLON      I      LONGITUDE OF S.W. CORNER OF OUTPUT DATA BASE   C
C       EW        I      VARIABLE TAKING VALUES 'EAST' OR 'NOT EAST'    C
C       I         I      INDEX VARIABLE FOR ROWS                        C
C       INT       I      FUNCTION OF 'INTVL'                            C
C       INTVL     I      DATA BASE TRANSFORMATION INTERVAL              C
C       J         I      INDEX VARIABLE FOR COLUMNS                     C
C       K         I      DUMMY VARIABLE                                 C
C       L         I**2   OUTPUT DATA BASE MATRIX                        C
C       NS        I      VARIABLE TAKING VALUES 'NORTH' OR 'NOT NORTH'  C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      INTEGER*2  L(400,400)
      INTEGER I,J,K,INTVL,EW,NS,DLAT,DLON,INT
      WRITE(5,1)
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C     MESSAGE REMINDING USER OF FILEDEF REQUIREMENTS FOLLOWED BY REQUEST C
C  FOR TRANSFORMATION INTERVAL AND LOCATION OF COMBINED DATA BASE S.W.  C
C  CORNER                                                               C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
 1    FORMAT(' PRIOR TO USING THIS PROGRAM SEVERAL FILES MUST BE DEFINED
     *.'/' IF YOU WANT TO COMBINE FOUR 1-DEGREE SQUARES YOU MUST FIRST D
     *EFINE FILEDEFS'/' 11-14. THE DATA SQUARES MUST HAVE BEEN TRANSFORM
     *ED BY THE PROGRAM "TRANS"'/' AND SHOULD BE NUMBERED LEFT TO RIGHT,
     *TOP TO BOTTOM.  FOR EXAMPLE'/' FILEDEF 11 SHOULD BE DATA FROM THE
     *NORTHWEST SQUARE, 12 FROM THE'/' NORTHEAST,13 FROM THE SOUTHWEST A
     *ND 14 FROM THE SOUTHEAST SQUARE.'/' SIMILARLY, IF YOU ARE COMBININ
     *G 16 SQUARES (4 BY 4) FILEDEFS 15-30'/' MUST BE USED,AGAIN STARTIN
     *G WITH 15 IN THE NORTHWEST CORNER PROCEEDING'/' TO 18 IN THE NORTH
     *EAST, 27 IN THE SOUTHWEST AND 30 IN THE SOUTHEAST.'/' THE SAME APP
     *LIES TO THE 5 BY 5 CASE USING FILEDEFS 31-55.'//)
      WRITE(5,100)
 100  FORMAT(' INPUT THE SAME DATA BASE INTERVAL YOU USED IN "TRANS".  F
     *OR A 2 BY 2'/' USE 18; FOR A 4 BY 4 USE 36 AND FOR A 5 BY 5 USE 45
     *.')
      READ(5,110) INTVL
 110  FORMAT(I2)
      WRITE(5,120)
 120  FORMAT(' ENTER THE LATITUDE AND LONGITUDE OF THE SOUTHWEST CORNER
```

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     *OF THE COMBINED'/' DATA BASE IN THE FOLLOWING FORMAT:NN OR SS IN CCOM00490
     *OLUMNS 1-2 DEPENDING ON WHETHER'/' THE CORNER IS ABOVE OR BELOW THCOM00500
     *E EQUATOR.')                                                      COM00510
      READ(5,130)NS                                                     COM00520
  130 FORMAT(A2)                                                        COM00530
      WRITE(5,140)                                                      COM00540
  140 FORMAT(' NOW ENTER THE LATITUDE (DDDMMSS) IN COLUMNS 1-7.')       COM00550
      READ(5,150)DLAT                                                   COM00560
  150 FORMAT(I7)                                                        COM00570
      WRITE(5,160)                                                      COM00580
  160 FORMAT(' NOW ENTER E OR W IN COLUMN 1 DEPENDING ON WHETHER THE CORCOM00590
     *NER IS EAST'/' OR WEST OF 0 DEGREES LONGITUDE.')                  COM00600
      READ(5,170)EW                                                     COM00610
  170 FORMAT(A1)                                                        COM00620
      WRITE(5,180)                                                      COM00630
  180 FORMAT(' NOW ENTER THE LONGITUDE (DDDMMSS) IN COLUMNS 1-7.')      COM00640
      READ(5,190)DLON                                                   COM00650
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCOM00660
C    SET UP VALUE OF BRANCHING VARIABLE                                CCOM00670
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCOM00680
      IF(INTVL.EQ.18)INT=1                                              COM00690
      IF(INTVL.EQ.36)INT=2                                              COM00700
      IF(INTVL.EQ.45)INT=3                                              COM00710
  190 FORMAT(I7)                                                        COM00720
  200 FORMAT(I2////)                                                    COM00730
  205 FORMAT(I7,1X,I7)                                                  COM00740
  210 FORMAT(40A2)                                                      COM00750
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC COM00760
C     DEPENDING ON TRANSFORMATION INTERVAL, BRANCH TO 18,36 OR 45.  IN CCOM00770
C ALL CASES READ THE APPROPRIATE FILES, PLACING THE DATA IN THE PROPER CCOM00780
C GEOGRAPHIC LOCATION.  THE ASSEMBLY OF FOUR FILES BEGINS AT 18        CCOM00790
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCOM00800
      GO TO(18,36,45),INT                                               COM00810
   18 READ(11,200)K                                                     COM00820
      DO 230 J=1,200                                                    COM00830
         READ(11,210)(L(I,J),I=1,200)                                   COM00840
  230 CONTINUE                                                          COM00850
      READ(12,200)K                                                     COM00860
      DO 250 J=201,400                                                  COM00870
         READ(12,210)(L(I,J),I=1,200)                                   COM00880
  250 CONTINUE                                                          COM00890
      READ(13,200)K                                                     COM00900
      DO 270 J=1,200                                                    COM00910
         READ(13,210)(L(I,J),I=201,400)                                 COM00920
  270 CONTINUE                                                          COM00930
      READ(14,200)K                                                     COM00940
      DO 290 J=201,400                                                  COM00950
         READ(14,210)(L(I,J),I=201,400)                                 COM00960
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  290 CONTINUE                                                          COM00970
      GO TO 1200                                                        COM00980
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCOM00990
C     THE ASSEMBLY OF SIXTEEN FILES BEGINS HERE                         CCOM01000
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCOM01010
   36 READ(15,200)K                                                     COM01020
      DO 310 J=1,100                                                    COM01030
         READ(15,210)(L(I,J),I=1,100)                                   COM01040
  310 CONTINUE                                                          COM01050
      READ(16,200)K                                                     COM01060
      DO 330 J=101,200                                                  COM01070
         READ(16,210)(L(I,J),I=1,100)                                   COM01080
  330 CONTINUE                                                          COM01090
      READ(17,200)K                                                     COM01100
      DO 340 J=201,300                                                  COM01110
         READ(17,210)(L(I,J),I=1,100)                                   COM01120
  340 CONTINUE                                                          COM01130
      READ(18,200)K                                                     COM01140
      DO 360 J=301,400                                                  COM01150
         READ(18,210)(L(I,J),I=1,100)                                   COM01160
  360 CONTINUE                                                          COM01170
      READ(19,200)K                                                     COM01180
      DO 380 J=1,100                                                    COM01190
         READ(19,210)(L(I,J),I=101,200)                                 COM01200
  380 CONTINUE                                                          COM01210
      READ(20,200)K                                                     COM01220
      DO 400 J=101,200                                                  COM01230
         READ(20,210)(L(I,J),I=101,200)                                 COM01240
  400 CONTINUE                                                          COM01250
      READ(21,200)K                                                     COM01260
      DO 420 J=201,300                                                  COM01270
         READ(21,210)(L(I,J),I=101,200)                                 COM01280
  420 CONTINUE                                                          COM01290
      READ(22,200)K                                                     COM01300
      DO 440 J=301,400                                                  COM01310
         READ(22,210)(L(I,J),I=101,200)                                 COM01320
  440 CONTINUE                                                          COM01330
      READ(23,200)K                                                     COM01340
      DO 460 J=1,100                                                    COM01350
         READ(23,210)(L(I,J),I=201,300)                                 COM01360
  460 CONTINUE                                                          COM01370
      READ(24,200)K                                                     COM01380
      DO 480 J=101,200                                                  COM01390
         READ(24,210)(L(I,J),I=201,300)                                 COM01400
  480 CONTINUE                                                          COM01410
      READ(25,200)K                                                     COM01420
      DO 500 J=201,300                                                  COM01430
         READ(25,210)(L(I,J),I=201,300)                                 COM01440
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500   CONTINUE                                                          COMO1450
      READ(26,200)K                                                     COMO1460
      DO 520 J=301,400                                                  COMO1470
         READ(26,210)(L(I,J),I=201,300)                                 COMO1480
520   CONTINUE                                                          COMO1490
      READ(27,200)K                                                     COMO1500
      DO 540 J=1,100                                                    COMO1510
         READ(27,210)(L(I,J),I=301,400)                                 COMO1520
540   CONTINUE                                                          COMO1530
      READ(28,200)K                                                     COMO1540
      DO 560 J=101,200                                                  COMO1550
         READ(28,210)(L(I,J),I=301,400)                                 COMO1560
560   CONTINUE                                                          COMO1570
      READ(29,200)K                                                     COMO1580
      DO 580 J=201,300                                                  COMO1590
         READ(29,210)(L(I,J),I=301,400)                                 COMO1600
580   CONTINUE                                                          COMO1610
      READ(30,200)K                                                     COMO1620
      DO 600 J=301,400                                                  COMO1630
         READ(30,210)(L(I,J),I=301,400)                                 COMO1640
600   CONTINUE                                                          COMO1650
      GO TO 1200                                                        COMO1660
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCOMO1670
C     THE ASSEMBLY CF TWENTY-FIVE FILES BEGINS HERE                    CCOMO1680
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCOMO1690
45    READ(31,200)K                                                     COMO1700
      DO 620 J=1,80                                                     COMO1710
         READ(31,210)(L(I,J),I=1,80)                                    COMO1720
620   CONTINUE                                                          COMO1730
      READ(32,200)K                                                     COMO1740
      DO 640 J=81,160                                                   COMO1750
         READ(32,210)(L(I,J),I=1,80)                                    COMO1760
640   CONTINUE                                                          COMO1770
      READ(33,200)K                                                     COMO1780
      DO 660 J=161,240                                                  COMO1790
         READ(33,210)(L(I,J),I=1,80)                                    COMO1800
660   CONTINUE                                                          COMO1810
      READ(34,200)K                                                     COMO1820
      DO 680 J=241,320                                                  COMO1830
         READ(34,210)(L(I,J),I=1,80)                                    COMO1840
680   CONTINUE                                                          COMO1850
      READ(35,200)K                                                     COMO1860
      DO 700 J=321,400                                                  COMO1870
         READ(35,210)(L(I,J),I=1,80)                                    COMO1880
700   CONTINUE                                                          COMO1890
      READ(36,200)K                                                     COMO1900
      DO 720 J=1,80                                                     COMO1910
         READ(36,210)(L(I,J),I=81,160)                                  COMO1920
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720   CONTINUE                                          COM01930
      READ(37,200)K                                     COM01940
      DO 740 J=81,160                                   COM01950
         READ(37,210)(L(I,J),I=81,160)                  COM01960
740   CONTINUE                                          COM01970
      READ(38,200)K                                     COM01980
      DO 760 J=161,240                                  COM01990
         READ(38,210)(L(I,J),I=81,160)                  COM02000
760   CONTINUE                                          COM02010
      READ(39,200)K                                     COM02020
      DO 780 J=241,320                                  COM02030
         READ(39,210)(L(I,J),I=81,160)                  COM02040
780   CONTINUE                                          COM02050
      READ(40,200)K                                     COM02060
      DO 800 J=321,400                                  COM02070
         READ(40,210)(L(I,J),I=81,160)                  COM02080
800   CONTINUE                                          COM02090
      READ(41,200)K                                     COM02100
      DO 820 J=1,80                                     COM02110
         READ(41,210)(L(I,J),I=161,240)                 COM02120
820   CONTINUE                                          COM02130
      READ(42,200)K                                     COM02140
      DO 840 J=81,160                                   COM02150
         READ(42,210)(L(I,J),I=161,240)                 COM02160
840   CONTINUE                                          COM02170
      READ(43,200)K                                     COM02180
      DO 860 J=161,240                                  COM02190
         READ(43,210)(L(I,J),I=161,240)                 COM02200
860   CONTINUE                                          COM02210
      READ(44,200)K                                     COM02220
      DO 880 J=241,320                                  COM02230
         READ(44,210)(L(I,J),I=161,240)                 COM02240
880   CONTINUE                                          COM02250
      READ(45,200)K                                     COM02260
      DO 900 J=321,400                                  COM02270
         READ(45,210)(L(I,J),I=161,240)                 COM02280
900   CONTINUE                                          COM02290
      READ(46,200)K                                     COM02300
      DO 920 J=1,80                                     COM02310
         READ(46,210)(L(I,J),I=241,320)                 COM02320
920   CONTINUE                                          COM02330
      READ(47,200)K                                     COM02340
      DO 940 J=81,160                                   COM02350
         READ(47,210)(L(I,J),I=241,320)                 COM02360
940   CONTINUE                                          COM02370
      READ(48,200)K                                     COM02380
      DO 960 J=161,240                                  COM02390
         READ(48,210)(L(I,J),I=241,320)                 COM02400
```

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960   CONTINUE                                                               COMO2410
      READ(49,200)K                                                          COMO2420
      DO 980 J=241,320                                                       COMO2430
         READ(49,210)(L(I,J),I=241,320)                                      COMO2440
980   CONTINUE                                                               COMO2450
      READ(50,200)K                                                          COMO2460
      DO 1000 J=321,400                                                      COMO2470
         READ(50,210)(L(I,J),I=241,320)                                      COMO2480
1000  CONTINUE                                                               COMO2490
      READ(51,200)K                                                          COMO2500
      DO 1020 J=1,80                                                         COMO2510
         READ(51,210)(L(I,J),I=321,400)                                      COMO2520
1020  CONTINUE                                                               COMO2530
      READ(52,200)K                                                          COMO2540
      DO 1040 J=81,160                                                       COMO2550
         READ(52,210)(L(I,J),I=321,400)                                      COMO2560
1040  CONTINUE                                                               COMO2570
      READ(53,200)K                                                          COMO2580
      DO 1060 J=161,240                                                      COMO2590
         READ(53,210)(L(I,J),I=321,400)                                      COMO2600
1060  CONTINUE                                                               COMO2610
      READ(54,200)K                                                          COMO2620
      DO 1080 J=241,320                                                      COMO2630
         READ(54,210)(L(I,J),I=321,400)                                      COMO2640
1080  CONTINUE                                                               COMO2650
      READ(55,200)K                                                          COMO2660
      DO 1100 J=321,400                                                      COMO2670
         READ(55,210)(L(I,J),I=321,400)                                      COMO2680
1100  CONTINUE                                                               COMO2690
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCOMO2700
C    WRITE THE DATA BASE HEADER AND OUTPUT THE FILE TO MASK DATA D1        CCOMO2710
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCOMO2720
1200  WRITE(8,110)INTVL                                                      COMO2730
      WRITE(8,170)EW                                                         COMO2740
      WRITE(8,205)GLON,DLON                                                  COMO2750
      WRITE(8,130)NS                                                         COMO2760
      WRITE(8,205)GLAT,DLAT                                                  COMO2770
      DO 1210 J=1,400                                                        COMO2780
         WRITE(8,210)(L(I,J),I=1,400)                                        COMO2790
1210  CONTINUE                                                               COMO2800
      STOP                                                                   COMO2810
      END                                                                    COMO2820
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CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C     THIS IS THE 'MASK' MAIN PROGRAM.  IT READS THE MASK DATA FILE,
C  ACCEPTS ALL USER INPUTS, CALLS ALL SUBROUTINES AND CREATES ALL OUT-
C  PUT FILES EXCEPT THE TOPOGRAPHIC DISPLAY, WHICH IS CREATED BY THE
C  'LOOK' SUBROUTINE.
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C     VARIABLE LISTING
C
C       NAME     TYPE                  FUNCTION
C
C       A         I     SYMBOL FOR THE CHARACTER '+'
C       ADD       I     INDICATOR VARIABLE FOR ADDITIONAL SITE CHOICE
C       AGL       R     STRIKE HEIGHT IN METERS ABOVE GROUND LEVEL
C       B         I     SYMBOL FOR THE CHARACTER '|'
C       BB        R     ANGLE BETWEEN (I,J) AND (M,N) MEASURED IN RADIANS
C                       AT THE CENTER OF THE EARTH
C       C         I     SYMBOL FOR THE CHARACTER '-'
C       CHAR      I     VECTOR OF CHARACTERS USED IN BUILDING AGL AND MSL
C                       DISPLAY MATRIX BORDERS
C       D         R     GROUND DISTANCE BETWEEN (I,J) AND (M,N)
C       DH        R     HEIGHT OF REFRACTIVE DUCT IN METERS ABOVE SEA LEVEL
C       DHF       I     HEIGHT OF REFRACTIVE DUCT IN FEET ABOVE SEA LEVEL
C       DI        R     INCREMENTAL DISTANCE BETWEEN (I,J) AND (II,JJ) IN
C                       THE NORTH-SOUTH DIRECTION
C       DISRES    I     DISPLAY RESOLUTION -- CURRENTLY SET AT ONE-TO-FIVE
C       DJ        R     INCREMENTAL DISTANCE BETWEEN (I,J) AND (II,JJ) IN
C                       THE EAST-WEST DIRECTION
C       DLAT      I     LATITUDE VALUE OF SOUTHWEST CORNER OF MASK DATA
C       DLON      I     LONGITUDE VALUE OF SOUTHWEST CORNER OF MASK DATA
C       DM        I     INDEX VARIABLE FOR ROWS OF AGL AND MSL DISPLAYS
C       DMMAX     I     MAX VALUE OF DM -- CURRENTLY SET AT 80
C       DN        I     INDEX VARIABLE FOR COLUMNS OF AGL AND MSL DISPLAYS
C       DNMAX     I     MAX VALUE OF DN -- CURRENTLY SET AT 80
C       DNDH      I     VALUE OF THE REFRACTIVE GRADIENT IN N-UNITS/KM
C       EW        I     INDICATOR VARIABLE FOR HEMISPHERE OF LONGITUDE OF
C                       EACH RADAR SITE
C       FAGL      I     INPUT AGL STRIKE ALTITUDE IN FEET
C       FMSL      I     INPUT MSL STRIKE ALTITUDE IN FEET
C       GLAT      I     LATITUDE VALUE OF SOUTHWEST CORNER OF PARENT DTED
C                       DATA FILE
C       GLON      I     LONGITUDE VALUE OF SOUTHWEST CORNER OF PARENT DTED
C                       DATA FILE
C       GNS       I     INDICATOR VARIABLE FOR HEMISPHERE OF LATITUDE FOR
C                       MASK DATA BASE
C       GWE       I     INDICATOR VARIABLE FOR HEMISPHERE OF LONGITUDE FOR
C                       MASK DATA BASE
C       HLL       I     HEIGHT OF CLOSEST DATA BASE ELEMENT TO THE SOUTH-
C                       WEST OF THE RADAR SITE
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C     HLR      I     HEIGHT OF CLOSEST DATA BASE ELEMENT TO THE SOUTH-   CMAS00490
C                    EAST OF THE RADAR SITE                              CMAS00500
C     HT       I     HEIGHT IN METERS OF ANY POINT (M,N) IN THE MASK     CMAS00510
C                    DATA BASE                                           CMAS00520
C     HUL      I     HEIGHT OF CLOSEST DATA BASE ELEMENT TO THE NORTH-   CMAS00530
C                    WEST OF THE RADAR SITE                              CMAS00540
C     HUR      I     HEIGHT OF CLOSEST DATA BASE ELEMENT TO THE NORTH-   CMAS00550
C                    EAST OF THE RADAR SITE                              CMAS00560
C     I        R     MATRIX EQUIVALENT VALUE OF THE LATITUDE OF THE      CMAS00570
C                    RADAR SITE                                          CMAS00580
C     IADIS    I     AGL DISPLAY MATRIX -- DIMENSIONED AT (80,80)        CMAS00590
C     IMDIS    I     MSL DISPLAY MATRIX -- DIMENSIONED AT (80,80)        CMAS00600
C     II       I     INTEGER VALUE OF 'I'                                CMAS00610
C     INTVL    I     TRANSFORMATION INTERVAL OF DATA BASE IN ARCSECONDS  CMAS00620
C     J        R     MATRIX EQUIVALENT VALUE OF THE LONGITUDE OF THE     CMAS00630
C                    RADAR SITE                                          CMAS00640
C     JJ       I     INTEGER VALUE OF 'J'                                CMAS00650
C     K        I     INDEX VARIABLE FOR SITE NUMBER                      CMAS00660
C     KMAX     I     TOTAL NUMBER OF SITES INPUT THUS FAR                CMAS00670
C     L        I**2  ELEVATION DATA DATA BASE MATRIX -- DIMENSIONEDC      MAS00680
C                    AT (400,400)                                        CMAS00690
C     LIH      R     INTERPOLATED HEIGHT OF RADAR SITE IN METERS         CMAS00700
C     LK       I     INDICATOR VARIABLE FOR TOPO DISPLAY SELECTION       CMAS00710
C     M        I     INDEX VARIABLE FOR ROWS OF MASK DATA BASE           CMAS00720
C     MAXV     DP    RADIAN MEASURE OF LOOK ANGLE BETWEEN VERTICAL AND   CMAS00730
C                    THE CP AS SEEN BY THE RADAR ANTENNA                 CMAS00740
C     MHT      R     OUTPUT VALUE OF ANTENNA HEIGHT ABOVE MSL IN FEET    CMAS00750
C     MMAX     I     MAX VALUE OF 'M' -- CURRENTLY 400                   CMAS00760
C     MODD     I     MOD(M,DISRES)--TAKES VALUES 1, 6, 11, 16, ..., 396  CMAS00770
C     MPPLAT   R     NUMBER OF METERS BETWEEN ELEVATION DATA POINTS IN   CMAS00780
C                    LATITUDE                                            CMAS00790
C     MPPLON   R     NUMBER OF METERS BETWEEN ELEVATION DATA POINTS IN   CMAS00800
C                    LONGITUDE                                           CMAS00810
C     MSL      R     MSL STRIKE ALTITUDE IN METERS                       CMAS00820
C     MUR      R     MAXIMUM UNAMBIGUOUS RANGE OF RADAR IN METERS        CMAS00830
C     N        I     INDEX VARIABLE FOR COLUMNS OF MASK DATA BASE        CMAS00840
C     NMAX     I     MAX VALUE OF N -- CURRENTLY 400                     CMAS00850
C     NODD     I     MOD(N,DISRES) -- SAME VALUES AS MODD                CMAS00860
C     NS       I     INDICATOR VALUE FOR HEMISPHERE OF LATITUDE OF RADAR CMAS00870
C                    SITE                                                CMAS00880
C     ORIG     R     HEIGHT OF ANTENNA IN METERS ABOVE SEA LEVEL         CMAS00890
C     PI       R     VALUE OF PI                                         CMAS00900
C     PRF      I     PULSE REPETITION FREQUENCY OF RADAR                 CMAS00910
C     R        I     FOUR-THIRDS EARTH RADIUS IN METERS                  CMAS00920
C     RAD      R     FUNCTION WHICH CONVERTS DEGREES TO RADIANS          CMAS00930
C     RD       I     EQUIVALENT EARTH RADIUS IN METERS PRODUCED BY USING CMAS00940
C                    DNDH                                                CMAS00950
C     RE       I     ACTUAL EARTH RADIUS IN METERS                       CMAS00960
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C      RESLAT   R    RESOLUTION OF DISPLAY MATRIX IN LATITUDE EXPRESSED
C                    IN NAUTICAL MILES
C      RESLON   R    RESOLUTION OF DISPLAY MATRIX IN LONGITUDE (NM)
C      RHF      I    INPUT VALUE OF SITE ELEVATION IN FEET ABOVE MSL
C      RHT      R    VALUE OF SITE ELEVATION IN METERS ABOVE MSL
C      RLAT     I    LATITUDE VALUE OF RADAR SITE
C      RLON     I    LONGITUDE VALUE OF RADAR SITE
C      RMHF     I    INPUT VALUE OF RADAR MAST HEIGHT IN FEET AGL
C      RMHT     R    VALUE OF RADAR MAST HEIGHT IN METERS MSL
C      SH       R    HORIZONTAL SLOPE BETWEEN (I,J) AND (M,N)
C      SP       I    SPACING VARIABLE USED IN DISPLAY CREATION
C      SR       R    SLANT RANGE IN METERS FROM SITE TO MSL TARGET AT CP
C      X        I    SYMBOL FOR THE CHARACTER ' '
C      Y        I    SYMBOL FOR THE CHARACTER '*'
C      Z        I    SYMBOL FOR THE CHARACTER '.'
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
       INTEGER INTVL,GWE,GNS,GLAT,GLON,M,N,K,ADD,KMAX,II,JJ
       INTEGER RLON(9),RLAT(9),EW(9),NS(9),RHF(9),RMHF(9),PRF(9)
       INTEGER MMAX,NMAX,FMSL,FAGL,DISRES,HT,DNDH,RD
       INTEGER DMMAX,DNMAX,HUL,HUR,HLL,HLR,DHF,R,RD
       INTEGER DM,DN,MODD,NODD,RE,Z/'.'/,LK,Y/'*'/
       INTEGER A/'+'/,B/'|'/,C/'-'/,CHAR(80),SP,X/' '/,DLON,DLAT
       INTEGER*2    L(400,400)
       COMMON   L,IADIS(80,80),IMDIS(80,80)
       REAL     PI,MPPLON,MPPLAT,SH,D,BB,MUR,SR,DH,MSL,AGL,ORIG,LIH
       REAL     RESLAT,RESLON,RAD,I,J,DI,DJ,RMHT(9),RHT(9),MHT(9)
       DOUBLE PRECISION  MAXV
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C    THIS IS THE BEGINNING OF THE INPUT PHASE.  RADAR SITE INPUTS ARE
C INCREMENTED IN THE 'K' LOOP, WHICH HAS A MAXIMUM CAPACITY OF NINE
C RADAR SITES.
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
       K=1
1      WRITE(5,620)K
       KMAX=K
620    FORMAT(1X,'INPUT RADAR SITE # ',I1,'  POSITION (NN OR SS) RELATIVE
     *'/' TO THE EQUATOR IN COLUMNS 1-2')
       READ(5,820)NS(K)
820    FORMAT(A2)
       WRITE(5,630)K
630    FORMAT(1X,'INPUT RADAR SITE # ',I1,'  LATITUDE (DDDMMSS) STARTING
     *'/' IN COLUMN 1')
       READ(5,810)RLAT(K)
       WRITE(5,600)K
600    FORMAT(1X,'INPUT RADAR SITE # ',I1,'  POSITION (E OR W) RELATIVE'/
     *' TO 0 DEGREES IN COLUMN 1')
       READ(5,800)EW(K)
800    FORMAT(A1)
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      WRITE(5,610)K                                                     MAS01450
610   FORMAT(1X,'INPUT RADAR SITE # ',I1,'  LONGITUDE (DDDMMSS) STARTINGMAS01460
     *'/' IN COLUMN 1')                                                 MAS01470
      READ(5,810)RLON(K)                                                MAS01480
810   FORMAT(I7)                                                        MAS01490
      WRITE(5,640)K                                                     MAS01500
640   FORMAT(1X,'INPUT RADAR SITE # ',I1,'  ELEVATION (FT MSL) OR -9999'MAS01510
     */' (IF UNKNOWN),RIGHT JUSTIFIED IN COLUMNS 1-5')                  MAS01520
      READ(5,840)RHF(K)                                                 MAS01530
840   FORMAT(I5)                                                        MAS01540
      WRITE(5,650)K                                                     MAS01550
650   FORMAT(1X,'INPUT RADAR # ',I1,'  MAST HEIGHT (FT) OR -99 (IF UNKNOMAS01560
     *WN)'/' RIGHT JUSTIFIED IN COLUMNS 1-3')                           MAS01570
      READ(5,850)RMHF(K)                                                MAS01580
850   FORMAT(I3)                                                        MAS01590
      WRITE(5,655)K                                                     MAS01600
655   FORMAT(1X,'TO OBTAIN CALCULATIONS BASED ON UNAMBIGUOUS RANGE',/1X,MAS01610
     *' (PULSE RADARS ONLY), INPUT RADAR # ',I1,'  PULSE REPETITION'/' FMAS01620
     *REQUENCY (PRF) RIGHT JUSTIFIED, INTEGER VALUED IN COLUMNS 1-4.'/' MAS01630
     *FOR RADARS USING TWO PRFS SIMULTANEOUSLY, ENTER THE ABSOLUTE'/' DIMAS01640
     *FFERENCE BETWEEN THE HIGHER AND LOWER PRFS.  IF UNAMBIGUOUS'/' RANMAS01650
     *GE CALCULATIONS NOT DESIRED, ENTER -999.')                        MAS01660
      READ(5,855)PRF(K)                                                 MAS01670
855   FORMAT(I4)                                                        MAS01680
      WRITE(5,660)K                                                     MAS01690
 660  FORMAT(' IF YOU WANT TO ENTER ADDITIONAL RADAR SITES ENTER 1,OTHERMAS01700
     *WISE ENTER 0'/' THE MAXIMUM NUMBER OF SITES ALLOWED IS 9 AND YOU HMAS01710
     *AVE ENTERED ',I1,' SO FAR.')                                      MAS01720
      READ(5,860)ADD                                                    MAS01730
860   FORMAT(I1)                                                        MAS01740
      IF(ADD.NE.1.OR.K.GT.8) GO TO 2                                    MAS01750
         K=K+1                                                          MAS01760
         GO TO 1                                                        MAS01770
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC MAS01780
C    THIS IS THE END OF THE RADAR SITE INPUT LOOP.  THE REST OF THE    C MAS01790
C  INPUT DATA APPLIES TO ALL SITES ENTERED BY THE USER.                C MAS01800
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC MAS01810
2     WRITE(5,670)                                                      MAS01820
670   FORMAT(1X,'INPUT STRIKE ALTITUDE IN FEET AGL RIGHT JUSTIFIED',1X,/MAS01830
     *'IN COLUMNS 1-4; INPUT -999 IF NO AGL MASKING FIGURES REQUIRED')  MAS01840
      READ(5,870)FAGL                                                   MAS01850
870   FORMAT(I4)                                                        MAS01860
      WRITE(5,680)                                                      MAS01870
680   FORMAT(1X,'INPUT STRIKE ALTITUDE IN FEET MSL RIGHT JUSTIFIED',1X,/MAS01880
     *'IN COLUMNS 1-5; INPUT -9999 IF NO MSL MASKING FIGURES REQUIRED') MAS01890
      READ(5,880)FMSL                                                   MAS01900
880   FORMAT(I5)                                                        MAS01910
      WRITE(5,690)                                                      MAS01920
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690   FORMAT(1X,'FOR OVERWATER PROPAGATION ENTER THE REFRACTIVE INDEX GRMAS01930
     *ADIENT'/' IN "N UNITS" PER KILOMETER, RIGHT JUSTIFIED (INCLUDING SMAS01940
     *IGN) IN'/' COLS 1-4.  MINIMUM PERMISSABLE VALUE IS -156.  FOR STANMAS01950
     *DARD PROPAGATION'/' ENTER -039.  IF AN OPTICAL HORIZON IS DESIRED,MAS01960
     *ENTER -020.')                                                     MAS01970
      READ(5,890)DNDH                                                   MAS01980
890   FORMAT(I4)                                                        MAS01990
      WRITE(5,700)                                                      MAS02000
700   FORMAT(1X,'FOR OVERWATER PROPAGATION ENTER THE DUCTING HEIGHT IN FMAS02010
     *EET'/' ABOVE SEA LEVEL, RIGHT JUSTIFIED IN COLS 1-5.  FOR STANDARDMAS02020
     *'/'  PROPAGATION (I.E. NO DUCT) ENTER 0.  TO USE A NON-STANDARD'/'MAS02030
     * GRADIENT FOR ALL ALTITUDES (E.G. FOR OPTICS) ENTER 99999.'///20X,MAS02040
     *'***WARNING***'/' IF THE TARGET IS ABOVE THE DUCT AND THE RADAR ISMAS02050
     * INSIDE THE'/' DUCT THE MODEL WILL BE UNRELIABLE AND WILL OVERESTIMAS02060
     *MATE THE'/' RANGE OF THE RADAR LINE OF SIGHT.')                   MAS02070
      READ(5,895) DHF                                                   MAS02080
895   FORMAT(I5)                                                        MAS02090
      DH=FLOAT(DHF)/3.28084                                             MAS02100
      DISRES=5                                                          MAS02110
      WRITE(5,710)                                                      MAS02120
710   FORMAT(1X,'IF YOU DESIRE A MAP DISPLAY OF THE AREA, CODED',/1X,'BYMAS02130
     * ELEVATION, INPUT 1, OTHERWISE INPUT 0')                          MAS02140
      READ(5,965)LK                                                     MAS02150
965   FORMAT(I1)                                                        MAS02160
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCMAS02170
C     ALL USER INPUTS HAVE BEEN READ.  THE NEXT PHASE READS IN THE     CMAS02180
C CONTENTS OF THE MASK DATA BASE STARTING WITH THE TRANSFORMATION      CMAS02190
C INTERVAL AND THE CORNER LOCATION VALUES.                             CMAS02200
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCMAS02210
      READ(4,900)INTVL                                                  MAS02220
900   FORMAT(I2)                                                        MAS02230
      READ(4,910)GWE                                                    MAS02240
910   FORMAT(A1)                                                        MAS02250
      READ(4,920)GLON,DLON                                              MAS02260
920   FORMAT(I7,1X,I7)                                                  MAS02270
      READ(4,930)GNS                                                    MAS02280
930   FORMAT(A2)                                                        MAS02290
      READ(4,920)GLAT,DLAT                                              MAS02300
      MMAX=400                                                          MAS02310
      NMAX=400                                                          MAS02320
      DO 10 N=1,NMAX                                                    MAS02330
            READ(4,940)(L(M,N),M=1,MMAX)                                MAS02340
940         FORMAT(40A2)                                                MAS02350
10    CONTINUE                                                          MAS02360
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCMAS02370
C     NEXT, VARIABLES ARE INITIALIZED, METRIC CONVERSIONS ARE MADE, THE CMAS02380
C CORRECT EQUIVALENT EARTH RADIUS IS COMPUTED AND THE DISPLAY MATRICES CMAS02390
C ARE SET TO THE MASKED CONDITION.                                     CMAS02400
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CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCMAS02410
      SP=(INTVL/3)*5                                                    MAS02420
      RE=6372815                                                        MAS02430
      RD=IRND(FLOAT(RE)/(1.0+(FLOAT(DNDH)*FLOAT(RE)*1.0 E-9)))          MAS02440
      R=IRND(FLOAT(RE)*1.330321)                                        MAS02450
      PI=2.0*ARSIN(1.0)                                                 MAS02460
      MSL=FLOAT(FMSL)/3.28084                                           MAS02470
      AGL=FLOAT(FAGL)/3.28084                                           MAS02480
      DMMAX=80                                                          MAS02490
      DNMAX=80                                                          MAS02500
      DO 11 DM=1,DMMAX                                                  MAS02510
         DO 12 DN=1,DNMAX                                               MAS02520
              IADIS(DM,DN)=Z                                            MAS02530
              IMDIS(DM,DN)=Z                                            MAS02540
 12      CONTINUE                                                       MAS02550
 11   CONTINUE                                                          MAS02560
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCMAS02570
C    IF DESIRED, THE TOPOGRAPHIC DISPLAY IS CREATED BY 'LOOK'           CMAS02580
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCMAS02590
      IF(LK.EQ.1)CALL LOOK(NMAX,MMAX,GWE,GNS,DLAT,DLON,DISRES,SP)       MAS02600
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCMAS02610
C    THE SITE NUMBER LOOP STARTS HERE AND IS INCREMENTED USING THE      CMAS02620
C INDEX VARIABLE 'K'.  THE PRF FOR SITE 'K' IS DEFAULT CHECKED AND      CMAS02630
C THE MAXIMUM UNAMBIGUOUS RANGE (MUR) IS COMPUTED AS A FIRST STEP.      CMAS02640
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCMAS02650
      DO 15 K=1,KMAX                                                    MAS02660
         IF(PRF(K).EQ.-999)PRF(K)=100                                   MAS02670
      MUR=2.997925E8/(2.0*FLOAT(PRF(K)))                                MAS02680
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCMAS02690
C    SITE 'K' IS LOCATED IN THE DATA BASE MATRIX IN LAT, LONG AND ALT.  CMAS02700
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCMAS02710
      CALL LOCATE(EW(K),RLON(K),NS(K),RLAT(K),RHT(K),RMHT(K),INTVL,DLON,MAS02720
     *DLAT,I,J,MMAX,RHF(K),RMHF(K))                                     MAS02730
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCMAS02740
C    SITE 'K' ELEVATION IS INTERPOLATED HERE                            CMAS02750
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCMAS02760
      II=INT(I)                                                         MAS02770
      JJ=INT(J)                                                         MAS02780
      DI=I-II                                                           MAS02790
      DJ=J-JJ                                                           MAS02800
      IF(II+1.GT.MMAX.OR.JJ+1.GT.NMAX) GO TO 13                         MAS02810
         HUL=L(II,JJ)                                                   MAS02820
         HUR=L(II,JJ+1)                                                 MAS02830
         HLL=L(II+1,JJ)                                                 MAS02840
         HLR=L(II+1,JJ+1)                                               MAS02850
         LIH=((1.0-DI)*(FLOAT(HUL)*(1.0-DJ)+FLOAT(HUR)*DJ))+(DI*(FLOAT(HMAS02860
     *LL)*(1.0-DJ)+FLOAT(HLR)*DJ))                                      MAS02870
         GO TO 14                                                       MAS02880
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13    LIH=L(II,JJ)                                                     MAS02890
14    IF(RHF(K).EQ.-9999)RHT(K)=LIH                                    MAS02900
      ORIG=RHT(K)+RMHT(K)                                              MAS02910
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCMAS02920
C   THE BASIC DISTANCE MEASURES MPPLAT AND MPPLON ARE COMPUTED         CMAS02930
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCMAS02940
      MPPLAT=30.89628*FLOAT(INTVL)                                     MAS02950
      MPPLON=MPPLAT*COS(RAD(RLAT(K)))                                  MAS02960
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCMAS02970
C   THE MASK DATA BASE IS SCANNED BY ROW USING THE INDEX 'M'           CMAS02980
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCMAS02990
      DO 20 M=1,MMAX                                                   MAS03000
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCMAS03010
C   NON DISPLAYABLE ROWS ARE DISCARDED                                 CMAS03020
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCMAS03030
         MODD=MOD(M,DISRES)                                            MAS03040
         IF(MODD.NE.1)GO TO 20                                         MAS03050
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCMAS03060
C   THE MATRIX IS SCANNED BY COLUMN USING THE INDEX 'N'                CMAS03070
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCMAS03080
         DO 30 N=1,NMAX                                                MAS03090
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCMAS03100
C   NON DISPLAYABLE COLUMNS ARE DISCARDED                              CMAS03110
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCMAS03120
              NODD=MOD(N,DISRES)                                       MAS03130
              IF(NODD.NE.1)GO TO 30                                    MAS03140
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCMAS03150
C   DISPLAY MATRIX INDICES ARE RELATED TO DATA BASE INDICES            CMAS03160
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCMAS03170
              DN=(N/DISRES)+1                                          MAS03180
              DM=(M/DISRES)+1                                          MAS03190
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCMAS03200
C  THE DISPLAY MATRIX GRID IS CREATED AND DUPLICATE PROCESSING CHECKED CMAS03210
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCMAS03220
              IF(K.NE.1.AND.IMDIS(DM,DN).NE.Z.AND.IADIS(DM,DN).NE.Z) GO MAS03230
     *TO 30                                                            MAS03240
              IF(.NOT.(MOD(DM,20).EQ.1.AND.MOD(DN,20).EQ.1)) GO TO 21  MAS03250
                   IMDIS(DM,DN)=A                                      MAS03260
                   IADIS(DM,DN)=A                                      MAS03270
                   GO TO 30                                            MAS03280
21            IF(MOD(DN,20).NE.1) GO TO 22                             MAS03290
                   IMDIS(DM,DN)=B                                      MAS03300
                   IADIS(DM,DN)=B                                      MAS03310
                   GO TO 30                                            MAS03320
22            IF(MOD(DM,20).NE.1) GO TO 23                             MAS03330
                   IMDIS(DM,DN)=C                                      MAS03340
                   IADIS(DM,DN)=C                                      MAS03350
                   GO TO 30                                            MAS03360
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CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC MAS03370
C     THE CP HEIGHT IS ACCESSED, MAXV IS INITIALIZED, GROUND DISTANCE   C MAS03380
C  IS COMPUTED FROM THE SITE TO THE CP AND SLANT RANGE IS COMPARED TO   C MAS03390
C  MAX UNAMBIGUOUS RANGE. IF SLANT RANGE IS BEYOND MUR, THE POINT IS    C MAS03400
C  MASKED AND NO FURTHER PROCESSING OCCURS FOR THIS (M,N) PAIR.         C MAS03410
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC MAS03420
 23         HT=L(M,N)                                                     MAS03430
            MAXV=-(PI/2.0)                                                MAS03440
            D=SQRT(((I-FLOAT(M))*MPPLAT)**2+((J-FLOAT(N))*MPPLON)**2)     MAS03450
            BB=D/FLOAT(RE)                                                MAS03460
            IF(((ORIG+FLOAT(RE))**2+(AGL+FLOAT(HT+RE))**2)-(2.0*(         MAS03470
     *ORIG+FLOAT(RE))*(AGL+FLOAT(HT+RE))*COS(BB)).GT.0.0)GO TO 31         MAS03480
                SR=0.0                                                    MAS03490
                GO TO 32                                                  MAS03500
 31         SR= SQRT(((ORIG+FLOAT(RE))**2+(AGL+FLOAT(HT+RE))**2)-(2.0*(MAS03510
     *ORIG+FLOAT(RE))*(AGL+FLOAT(HT+RE))*COS(BB)))                        MAS03520
 32         IF(SR.LE.MUR) GO TO 33                                        MAS03530
                IF(K.NE.1) GO TO 30                                       MAS03540
                    IADIS(DM,DN)=Z                                        MAS03550
                    IMDIS(DM,DN)=Z                                        MAS03560
                    GO TO 30                                              MAS03570
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCMAS03580
C     HORIZONTAL SLOPE IS COMPUTED.  IF ITS ABSOLUTE VALJE IS LESS THAN  CMAS03590
C  OR EQUAL TO ONE, LONSCN IS CALLED.  OTHERWISE LATSCN IS CALLED.      CMAS03600
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCMAS03610
 33         IF(JJ.EQ.N)GO TO 34                                           MAS03620
                SH=(FLOAT(M)-I)/(J-FLOAT(N))                              MAS03630
                GO TO 35                                                  MAS03640
 34         SH= 1E10                                                      MAS03650
 35         IF(II.EQ.M.AND.JJ.EQ.N) GO TO 50                              MAS03660
                IF(ABS(SH).GT.1.0) GO TO 40                               MAS03670
                    CALL LONSCN(MPPLON,MPPLAT,I,J,M,N,SH,ORIG,MAXV,RMAS03680
     *,MMAX,II,JJ,DJ,RD,DH)                                               MAS03690
                    GO TO 60                                              MAS03700
40              CALL LATSCN(MPPLON,MPPLAT,I,J,M,N,SH,ORIG,MAXV,R,NMAXMAS03710
     *,II,JJ,DI,RD,DH)                                                    MAS03720
                GO TO 60                                                  MAS03730
50          MAXV=0.0                                                      MAS03740
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCMAS03750
C     COMPAR IS FED THE VALUE OF MAXV FROM LATSCN OR LONSCN AND DETER-   CMAS03760
C  MINES WHETHER OR NOT THE AGL AND MSL STRIKE ALTITUDES ABOVE THE CP    CMAS03770
C  ARE ABOVE OR BELOW THE COMPUTED MASKING HEIGHT.  THE POSITION IN      CMAS03780
C  BOTH DISPLAY MATRICES IS ASSIGNED THE APPROPRIATE INDICATOR VARIABLE.CMAS03790
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCMAS03800
60          CALL COMPAR(MAXV,R,M,N,ORIG,D,HT,AGL,MSL,DM,DN,DISRES,K,KMMAS03810
     *AX,II,JJ,RD,DH)                                                     MAS03820
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCMAS03830
C     N IS INCREMENTED BY ONE COLUMN                                     CMAS03840
```

```
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCMAS03850
30       CONTINUE                                                       MAS03860
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCMAS03870
C    M IS INCREMENTED BY ONE ROW                                       CMAS03880
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCMAS03890
20    CONTINUE                                                          MAS03900
      MHT(K)=ORIG*3.28084                                               MAS03910
      WRITE(5,25)K,KMAX                                                 MAS03920
25    FORMAT(' CALCULATIONS COMPLETE FOR ',I1,' OF ',I1,' RADAR SITES.')MAS03930
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCMAS03940
C    K IS INCREMENTED, MOVING TO THE NEXT INPUT RADAR SITE             CMAS03950
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCMAS03960
15    CONTINUE                                                          MAS03970
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCMAS03980
C    MASKING CALCULATIONS ARE COMPLETE.  OUTPUT PHASE BEGINS.          CMAS03990
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCMAS04000
      RESLAT=(MPPLAT*FLOAT(DISRES))/1852.0                              MAS04010
      RESLON=(MPPLON*FLOAT(DISRES))/1852.0                              MAS04020
      DO 51 DN=1,79                                                     MAS04030
         CHAR(DN)=C                                                     MAS04040
51    CONTINUE                                                          MAS04050
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCMAS04060
C    IF AGL DISPLAY IS NOT DESIRED, SKIP THIS SECTION                  CMAS04070
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCMAS04080
      IF(FAGL.EQ.-999) GO TO 75                                         MAS04090
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCMAS04100
C    INDICATOR VARIABLES FOR EACH POSITION IN AGL DISPLAY MATRIX ARE   CMAS04110
C PROCESSED TO CREATE THE AGL MASKING ENVELOPE.  ELEMENTS WHICH DO     CMAS04120
C NOT FORM THE ENVELOPE ARE BLANKED.                                   CMAS04130
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCMAS04140
      DO 52 DM=2,DMMAX                                                  MAS04150
         DO 53 DN=2,DNMAX                                               MAS04160
              IF(IADIS(DM,DN).NE.Z.AND.IADIS(DM,DN).NE.B.AND.IADIS(DM,DNMAS04170
     *).NE.C)GO TO 53                                                   MAS04180
              IF(IADIS(DM,DN).EQ.B.AND.IADIS(DM,DN+1).EQ.X.AND.IADIS(DM,MAS04190
     *DN-1).EQ.X)GO TO 53                                               MAS04200
              IF(IADIS(DM,DN).EQ.C.AND.IADIS(DM+1,DN).EQ.X.AND.IADIS(DM-MAS04210
     *1,DN).EQ.X)GO TO 53                                               MAS04220
              IF(IADIS(DM,DN+1).NE.X.AND.IADIS(DM,DN-1).NE.X.AND.IADI   MAS04230
     *S(DM+1,DN).NE.X.AND.IADIS(DM-1,DN).NE.X)GO TO 53                  MAS04240
                   IADIS(DM,DN)=Y                                       MAS04250
53       CONTINUE                                                       MAS04260
52    CONTINUE                                                          MAS04270
      DO 54 DM=2,DMMAX                                                  MAS04280
         DO 55 DN=2,DNMAX                                               MAS04290
              IF(IADIS(DM,DN).EQ.Z)IADIS(DM,DN)=X                       MAS04300
55       CONTINUE                                                       MAS04310
54    CONTINUE                                                          MAS04320
```

```
      WRITE(6,960)                                                      MAS04330
960   FORMAT('1')                                                       MAS04340
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCMAS04350
C     THE AGL DISPLAY NARRATIVE PAGE AND LEGEND ARE CREATED            CMAS04360
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCMAS04370
      WRITE(6,970)FAGL,DLAT,GNS,DLON,GWE,SP,RESLAT,RESLON,DNDH,DHF      MAS04380
970   FORMAT(T8,'RADAR COVERAGE DISPLAY FOR STRIKE AT ',I4,' FEET ABOVE MAS04390
     *GROUND LEVEL'////1X,'I. DISPLAY PARAMETERS'//5X,'SOUTHWEST CORNER MAS04400
     *OF DISPLAY:LATITUDE=',I7,1X,A2/33X,'LONGITUDE=',I7,1X,A1//5X,'GRIDMAS04410
     * SPACING=',I2,' MINUTES'//5X,'CELL RESOLUTION:LATITUDE=',F7.4,' NMMAS04420
     *'/21X,'LONGITUDE=',F7.4,' NM'//5X,'REFRACTIVE GRADIENT =',I4//5X,'MAS04430
     *REFRACTIVE DUCT HEIGHT (FT) =',I5////1X,'II. RADAR SITE PARAMETERSMAS04440
     *'///5X,'SITE #',4X,'LATITUDE',2X,'N/S',4X,'LONGITUDE',2X,'E/W',4X,MAS04450
     *'ELEVATION (FEET)',7X,'PRF'/)                                     MAS04460
      DO 971 K=1,KMAX                                                   MAS04470
         WRITE(6,972)K,RLAT(K),NS(K),RLON(K),EW(K),MHT(K),PRF(K)        MAS04480
972      FORMAT(7X,I1,7X,I7,4X,A2,5X,I7,4X,A1,9X,F8.2,10X,I4/)          MAS04490
971   CONTINUE                                                          MAS04500
      WRITE(6,973)                                                      MAS04510
973   FORMAT(////1X,'III. LEGEND'//5X,'##=NUMBERED RADAR SITE LOCATION'/MAS04520
     */5X,'**=ENVELOPE WITHIN WHICH AN AIRCRAFT FLYING AT'/8X,'THE SPECIMAS04530
     *FIED ALTITUDE WILL BE UNMASKED'/8X,'AND INSIDE THE RADAR MAXIMUM UMAS04540
     *NAMBIGUOUS RANGE.')                                               MAS04550
      WRITE(6,960)                                                      MAS04560
      WRITE(6,980)(IADIS(1,DN),DN=1,DNMAX),A                            MAS04570
      DO 70 DM=2,DMMAX                                                  MAS04580
         WRITE(6,980)(IADIS(DM,DN),DN=1,DNMAX),B                        MAS04590
980      FORMAT(1X,81A1)                                                MAS04600
70    CONTINUE                                                          MAS04610
      WRITE(6,980)A,(CHAR(DN),DN=1,79),A                                MAS04620
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCMAS04630
C     AGL DISPLAY COMPLETED.  IF MSL DISPLAY NOT DESIRED, OUTPUT THE AGL CMAS04640
C MATRIX TO MASK CUT FILE. OTHERWISE, PERFORM SIMILAR OPERATIONS FOR   CMAS04650
C MSL DISPLAY MATRIX AND OUTPUT TO MASK OUT.                           CMAS04660
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCMAS04670
75    IF(FMSL.EQ.-9999)GO TO 85                                         MAS04680
      DO 76 DM=2,DMMAX                                                  MAS04690
         DO 77 DN=2,DNMAX                                               MAS04700
            IF(IMDIS(DM,DN).NE.Z.AND.IMDIS(DM,DN).NE.B.AND.IMDIS(DM,DNMAS04710
     *).NE.C)GO TO 77                                                   MAS04720
            IF(IMDIS(DM,DN).EQ.B.AND.IMDIS(DM,DN+1).EQ.X.AND.IMDIS(DM,MAS04730
     *DN-1).EQ.X)GO TO 77                                               MAS04740
            IF(IMDIS(DM,DN).EQ.C.AND.IMDIS(DM+1,DN).EQ.X.AND.IMDIS(DM-MAS04750
     *1,DN).EQ.X)GO TO 77                                               MAS04760
            IF(IMDIS(DM,DN+1).NE.X.AND.IMDIS(DM,DN-1).NE.X.AND.IMDI    MAS04770
     *S(DM+1,DN).NE.X.AND.IMDIS(DM-1,DN).NE.X)GO TO 77                  MAS04780
               IMDIS(DM,DN)=Y                                           MAS04790
77       CONTINUE                                                       MAS04800
```

```
76    CONTINUE                                                              MAS04810
      DO 78 DM=2,DMMAX                                                      MAS04820
         DO 79 DN=2,DNMAX                                                   MAS04830
            IF(IMDIS(DM,DN).EQ.Z)IMDIS(DM,DN)=X                             MAS04840
79       CONTINUE                                                           MAS04850
78    CONTINUE                                                              MAS04860
      WRITE(6,960)                                                          MAS04870
      WRITE(6,990)FMSL,DLAT,GNS,DLON,GWE,SP,RESLAT,RESLON,DNDH,DHF          MAS04880
990   FORMAT(I8,' RADAR COVERAGE DISPLAY FOR STRIKE AT ',I5,' FEET ABOVE    MAS04890
     *SEA LEVEL   '////1X,'I. DISPLAY PARAMETERS'//5X,'SOUTHWEST CORNER    MAS04900
     *OF DISPLAY:LATITUDE=',I7,1X,A2/33X,'LONGITUDE=',I7,1X,A1//5X,'GRIDMAS04910
     * SPACING=',I2,' MINUTES'//5X,'CELL RESOLUTION:LATITUDE=',F7.4,' NMMAS04920
     *'/21X,'LONGITUDE=',F7.4,' NM'//5X,'REFRACTIVE GRADIENT =',I4//5X,'MAS04930
     *REFRACTIVE CUCT HEIGHT (FT) =',I5////1X,'II. RADAR SITE PARAMETERSMAS04940
     *'///5X,'SITE #',4X,'LATITUDE',2X,'N/S',4X,'LONGITUDE',2X,'E/W',4X,MAS04950
     *'ELEVATION (FEET)',7X,'PRF'/)                                        MAS04960
      DO 991 K=1,KMAX                                                       MAS04970
         WRITE(6,972)K,RLAT(K),NS(K),RLON(K),EW(K),MHT(K),PRF(K)            MAS04980
991   CONTINUE                                                              MAS04990
      WRITE(6,993)                                                          MAS05000
993   FORMAT(////1X,'III. LEGEND'//5X,'##=NUMBERED RADAR SITE LOCATION'/MAS05010
     */5X,'**=ENVELOPE WITHIN WHICH AN AIRCRAFT FLYING AT'/8X,'THE SPECIMAS05020
     *FIED ALTITUDE WILL BE UNMASKED'/8X,'AND INSIDE THE RADAR MAXIMUM UMAS05030
     *NAMBIGUOUS RANGE.'//5X,'OO=AREAS WHERE TERRAIN ELEVATION EXCEEDS AMAS05040
     *IRCRAFT'/8X,'ALTITUDE.')                                              MAS05050
      WRITE(6,960)                                                          MAS05060
      WRITE(6,980)(IMDIS(1,DN),DN=1,DNMAX),A                                MAS05070
      DO 80 DM=2,DMMAX                                                      MAS05080
         WRITE(6,980) (IMDIS(DM,DN),DN=1,DNMAX),B                           MAS05090
80    CONTINUE                                                              MAS05100
      WRITE(6,980)A,(CHAR(DN),DN=1,79),A                                    MAS05110
85    CONTINUE                                                              MAS05120
      STOP                                                                  MAS05130
      END                                                                   MAS05140
```

```
      SUBROUTINE LOOK(NMAX,MMAX,GWE,GNS,DLAT,DLON,DISRES,SP)
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C    THIS IS THE 'LOOK' SUBROUTINE.  IT CREATES A TOPOGRAPHIC DISPLAY   C
C OF THE MASK DATA BASE BEING USED BY MASK.                             C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C                                                                      C
C   VARIABLE LISTING. ONLY THOSE VARIABLES NOT INCLUDED IN THE MAIN    C
C  PROGRAM VARIABLE LISTING WILL BE EXPLAINED BELOW.                    C
C                                                                      C
C      NAME   TYPE                    FUNCTION                         C
C                                                                      C
C      IMAX     I     ROW INDEX VARIABLE SET TO 80                     C
C      JMAX     I     COLUMN INDEX VARIABLE SET TO 80                  C
C      OUT      I     HOLDING MATRIX FOR ELEVATION CODE                C
C      PIC      I     OUTPUT MATRIX CONTAINING PROCESSED ELEVATION CODE C
C      VARIOUS CHARACTERS ARE ADDITIONALLY USED TO DENOTE ELEVATION    C
C CODES AND ARE LISTED IN THE VARIABLE DEFINITION STATEMENTS BELOW.    C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      INTEGER OUT(80,80),NMAX,M,N,I,J,IMAX,JMAX,CHAR(80),SP
      INTEGER PIC(80,80)
      INTEGER*2    L(400,400)
      COMMON L
      INTEGER O/'O'/,P/'P'/,Q/'Q'/,R/'R'/,S/'S'/,T/'T'/,U/'U'/,V/'V'/
      INTEGER W/'W'/,X/'X'/,Y/'Y'/,Z/'Z'/,GWE,GNS,DLAT,DLON,DISRES
      INTEGER A/'+'/,B/'|'/,C/'-'/,D/' '/,E/'.'/,EE/'E'/
      INTEGER F/'K'/,G/'L'/,H/'M'/,K/'N'/
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C    ESTABLISH RELATION BETWEEN DISPLAY AND DATA BASE INDEX MAXIMA      C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      IMAX=MMAX/DISRES
      JMAX=NMAX/DISRES
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C    LOOP THROUGH ROWS FIVE AT A TIME                                  C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      DO 10 M=1,MMAX,DISRES
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C    LOOP THROUGH COLUMNS FIVE AT A TIME                               C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
         DO 20 N=1,NMAX,DISRES
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C    ESTABLISH RELATION BETWEEN DATA BASE AND DISPLAY INDEX VARIABLES   C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
            I=(M+DISRES-1)/DISRES
            J=(N+DISRES-1)/DISRES
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C    ASSIGN ELEVATION CODES FOR EACH DISPLAY MATRIX ELEMENT             C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
            IF(L(M,N).EQ.0)OUT(I,J)=EE
```

```
            IF(L(M,N).GT.0000.AND.L(M,N).LT.0050)OUT(I,J)=F
            IF(L(M,N).GE.0050.AND.L(M,N).LT.0100)OUT(I,J)=G
            IF(L(M,N).GE.0100.AND.L(M,N).LT.0200)OUT(I,J)=H
            IF(L(M,N).GE.0200.AND.L(M,N).LT.0300)OUT(I,J)=K
            IF(L(M,N).GE.0300.AND.L(M,N).LT.0500)OUT(I,J)=O
            IF(L(M,N).GE.0500.AND.L(M,N).LT.0700)OUT(I,J)=P
            IF(L(M,N).GE.0700.AND.L(M,N).LT.0900)OUT(I,J)=Q
            IF(L(M,N).GE.0900.AND.L(M,N).LT.1100)OUT(I,J)=R
            IF(L(M,N).GE.1100.AND.L(M,N).LT.1300)OUT(I,J)=S
            IF(L(M,N).GE.1300.AND.L(M,N).LT.1500)OUT(I,J)=T
            IF(L(M,N).GE.1500.AND.L(M,N).LT.1800)OUT(I,J)=U
            IF(L(M,N).GE.1800.AND.L(M,N).LT.2100)OUT(I,J)=V
            IF(L(M,N).GE.2100.AND.L(M,N).LT.2400)OUT(I,J)=W
            IF(L(M,N).GE.2400.AND.L(M,N).LT.2700)OUT(I,J)=X
            IF(L(M,N).GE.2700.AND.L(M,N).LT.3000)OUT(I,J)=Y
            IF(L(M,N).GE.3000)OUT(I,J)=Z
 20       CONTINUE
 10    CONTINUE
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C     CODE ASSIGNMENT LOOPS COMPLETED.  THE NEXT LOOP BLANKS OUT ALL    C
C  CODES WHICH ARE NOT PART OF AN ELEVATION TRANSITION.  THIS FORMS     C
C  CONTOUR LINES FROM THE CODE AND REMOVES EXTRANEOUS INFORMATION.      C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
       DO 30 I=1,IMAX
          DO 40 J=1,JMAX
             PIC(I,J)=OUT(I,J)
             IF(OUT(I,J).GT.OUT(I+1,J).OR.OUT(I,J).GT.OUT(I-1,J).OR.OUT
     *(I,J).GT.OUT(I,J+1).OR.OUT(I,J).GT.OUT(I,J-1))GO TO 40
                PIC(I,J)=D
                IF(OUT(I,J).EQ.EE)PIC(I,J)=E
 40       CONTINUE
 30    CONTINUE
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C     THIS SECTION DRAWS THE GRID LINES AND BORDERS ON THE DISPLAY      C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
       DO 50 I=1,IMAX
          DO 60 J=1,JMAX
             IF(I.EQ.1.OR.J.EQ.1)GO TO 61
             IF(PIC(I,J).NE.D.AND.PIC(I,J).NE.E) GO TO 60
 61          IF(.NOT.(MOD(I,20).EQ.1.AND.MOD(J,20).EQ.1)) GO TO 62
                PIC(I,J)=A
                GO TO 60
 62          IF(MOD(J,20).NE.1) GO TO 63
                PIC(I,J)=B
                GO TO 60
 63          IF(MOD(I,20).NE.1) GO TO 60
                PIC(I,J)=C
 60       CONTINUE
```

```
50    CONTINUE
      WRITE(6,110)(PIC(1,J),J=1,JMAX),A
      DO 70 I=2,IMAX
            WRITE(6,110)(PIC(I,J),J=1,JMAX),B
110         FORMAT(1X,81A1)
70    CONTINUE
      DO 80 J=1,79
        CHAR(J)=C
80    CONTINUE
      WRITE(6,110)A,(CHAR(J),J=1,79),A
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C     THIS SECTION LABELS THE DISPLAY AND CREATES THE LEGEND           C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      WRITE(6,120)GWE,DLON,GNS,DLAT,SP
120   FORMAT(T25,'CODED TOPOGRAPHIC MAP OF AREA'/' SOUTHWEST CORNER IS
     *',A1,1X,I7,2X,A2,I7/' GRID SPACING=',I2,' MINUTES.'//T30,' LEGEND'
     */10X,'SYMBOL',10X,'ELEVATION (METERS)'/12X,'.',14X,'SEA LEVEL'/13X
     *,'K',17X,'50'/13X,'L',16X,'100'/13X,'M',16X,'200'/13X,'N',16X,'300
     *'/13X,'O',16X,'500'/13X,'P',16X,'700'/13X,'Q',16X,'900'/13X,'R',15
     *X,'1100'/13X,'S',15X,'1300'/13X,'T',15X,'1500'/13X,'U',15X,'1800'/
     *13X,'V',15X,'2100'/13X,'W',15X,'2400'/13X,'X',15X,'2700'/13X,'Y',1
     *5X,'3000'/13X,'Z',15X,'3000 PLUS')
      RETURN
      END
```

```
      SUBROUTINE LOCATE(EW,RLON,NS,RLAT,RHT,RMHT,INTVL,DLON,DLAT,I,J,MMALOC00010
     *X,RHF,RMHF)                                                        LOC00020
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCLOC00030
C    THIS SUBROUTINE IS CALLED 'LOCATE'.  IT USES THE DATA BASE INTER-  CLOC00040
C VAL, LATITUDE AND LONGITUDE OF THE DATA BASE SOUTHWEST CORNER AND     CLOC00050
C LATITUDE AND LONGITUDE OF THE SITE TO COMPUTE A MATRIX POSITION FOR   CLOC00060
C THE SITE.  IN ADDITION, IT PERFORMS METRIC CONVERSION OF ANY INPUT    CLOC00070
C VALUES FOR SITE ELEVATION OR ANTENNA HEIGHT.                          CLOC00080
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCLOC00090
C                                                                       CLOC00100
C    VARIABLE LISTING.  ONLY THOSE VARIABLES NOT LISTED IN THE MAIN     CLOC00110
C  PROGRAM VARIABLE LISTING ARE EXPLAINED BELOW.                        CLOC00120
C                                                                       CLOC00130
C       NAME   TYPE                    FUNCTION                         CLOC00140
C                                                                       CLOC00150
C       EW       I     VARIABLE SPECIFYING EITHER EAST OR WEST          CLOC00160
C                      LONGITUDE                                        CLOC00170
C       NS       I     VARIABLE SPECIFYING EITHER NORTH OR SOUTH        CLOC00180
C                      LATITUDE                                         CLOC00190
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCLOC00200
      REAL      I,J,RMHT,RHT                                             LOC00210
      INTEGER EW,RLON,NS,RLAT,RHF,RMHF,INTVL,DLON,DLAT                   LOC00220
      INTEGER NN/'NN'/,E/'E'/                                            LOC00230
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCLOC00240
C    IF SITE IS IN WESTERN HEMISPHERE, SKIP THIS.  IN EITHER CASE, CAL- CLOC00250
C CULATE THE VALUE OF 'J' CORRESPONDING TO SITE LONGITUDE.              CLOC00260
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCLOC00270
      IF(EW.NE.E) GO TO 10                                               LOC00280
         J=FLOAT(IASEC(RLON)-IASEC(DLON))/FLOAT(INTVL)+1.0               LOC00290
         GO TO 20                                                        LOC00300
10    J=FLOAT(IASEC(DLON)-IASEC(RLON))/FLOAT(INTVL)+1.0                  LOC00310
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCLOC00320
C    IF SITE IS IN SOUTHERN HEMISPHERE, SKIP THIS.  IN EITHER CASE, CAL-CLOC00330
C CULATE THE VALUE OF 'I' CORRESPONDING TO SITE LATITUDE.               CLOC00340
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCLOC00350
20    IF(NS.NE.NN) GO TO 30                                              LOC00360
         I=FLOAT(MMAX)-(FLOAT(IASEC(RLAT)-IASEC(DLAT))/FLOAT(INTVL))+1.0LOC00370
         GO TO 40                                                        LOC00380
30    I=FLOAT(MMAX)-(FLOAT(IASEC(DLAT)-IASEC(RLAT))/FLOAT(INTVL))+1.0    LOC00390
40    IF(I.GE.400.0) I=400.0                                             LOC00400
      IF(J.GE.400.0) J=400.0                                             LOC00410
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCLOC00420
C    THIS SECTION CHECKS FOR SITE ELEVATION AND ANTENNA HEIGHT INPUT    CLOC00430
C VALUES AND DOES METRIC CONVERSIONS OF ANY INPUTS ENTERED AS FEET.     CLOC00440
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCLOC00450
      IF(RHF.NE.-9999) GO TO 50                                          LOC00460
         GO TO 60                                                        LOC00470
50    RHT=FLOAT(RHF)/3.28084                                             LOC00480
```

```
60     IF(RMHF.NE.-99)GO TO 70                                          LOC00490
          RMHT=5.0                                                      LOC00500
          GO TO 80                                                      LOC00510
70     RMHT=FLOAT(RMHF)/3.28084                                         LOC00520
80     CONTINUE                                                         LOC00530
       RETURN                                                           LOC00540
       END                                                              LOC00550
```

```
      SUBROUTINE LATSCN(MPPLON,MPPLAT,I,J,M,N,SH,ORIG,MAXV,R,NMAX,II,JJ,
     *DI,RD,DH)
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C    THIS IS THE 'LATSCN' SUBROUTINE.  IT SCANS ALONG THE LINE OF SIGHT C
C BETWEEN THE CP AND THE SITE, SAMPLING ELEVATIONS AND DETERMINING THE  C
C ANGLE OF THE LINE OF SIGHT AT ALL INTERMEDIATE SAMPLE POINTS.  THE    C
C LARGEST OF THESE IS RETURNED TO THE MAIN PROGRAM AS 'MAXV'.           C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C                                                                       C
C    VARIABLE LISTING. ONLY THOSE VARIABLES NOT CONTAINED IN THE MAIN   C
C PROGRAM VARIABLE LISTING ARE EXPLAINED BELOW.                         C
C                                                                       C
C      NAME   TYPE                  FUNCTION                            C
C                                                                       C
C      ALPH    DP    HALF ANGLE SUBTENDED BY GROUND DISTANCE BETWEEN THE C
C                    SITE AND THE SAMPLE POINT.                         C
C      BETA    DP    LOOK ANGLE FORMED BETWEEN THE EQUIVALENT HEIGHTS   C
C                    OF THE SITE AND THE SAMPLE POINT                   C
C      C1      I     BINARY INDICATOR BASED ON CP QUADRANT              C
C      C2      I     OPPOSITE OF 'C1'                                   C
C      D       R     GROUND DISTANCE BETWEEN TWO ADJACENT LINES, ONE M- C
C                    UNIT APART CONNECTED BY A LINE OF SLOPE SH         C
C      D1      DP    DOUBLE PRECISION VALUE OF 1                        C
C      D2      DP    DOUBLE PRECISION VALUE OF 2                        C
C      DDK     DP    DOUBLE PRECISION VALUE OF 'DK'                     C
C      DEL     R     INCREMENTAL DISTANCE WHOSE MAGNITUDE IS 'DI' AND   C
C                    WHOSE SIGN DEPENDS ON THE CP QUADRANT              C
C      DIST    DP    EQUIVALENT FLAT EARTH DISTANCE FROM SITE TO SAMPLE C
C                    POINT                                              C
C      DK      R     GROUND DISTANCE FROM SITE TO SAMPLE POINT          C
C      DORIG   DP    DOUBLE PRECISION VALUE OF 'ORIG'                   C
C      DPI     DP    DOUBLE PRECISION VALUE OF PI                       C
C      DR      DP    DOUBLE PRECISION VALUE OF 'R'                      C
C      DRD     DP    DOUBLE PRECISION VALUE OF 'RD'                     C
C      H1      DP    EQUIVALENT FLAT EARTH ELEVATION OF RADAR SITE      C
C      H2      DP    EQUIVALENT FLAT EARTH ELEVATION OF SAMPLE POINT    C
C      HT      R     INTERPOLATED ELEVATION VALUE OF SAMPLE POINT       C
C      K       I     INDEX VARIABLE USED IN SELECTING SAMPLE POINTS     C
C      KK      I     VARIABLE EQUAL IN MAGNITUDE TO 'K' WITH SIGN       C
C                    DEPENDING ON CP QUADRANT                           C
C      KMAX    I     MAX VALUE OF 'K'                                   C
C      QL      I     ELEVATION VALUE OF DATA BASE ELEMENT IMMEDIATELY   C
C                    WEST OF THE SAMPLE POINT                           C
C      QR      I     ELEVATION VALUE OF DATA BASE ELEMENT IMMEDIATELY   C
C                    EAST OF THE SAMPLE POINT                           C
C      SV      DP    ELEVATION ANGLE BETWEEN THE SITE AND ANY SAMPLE    C
C                    POINT MEASURED IN RADIANS FROM THE VERTICAL        C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
```

```
      INTEGER*2     L(400,400)                                          LAT00490
      COMMON   L                                                        LAT00500
      REAL     MPPLON,MPPLAT,SH,D,DK,I,J,DI,DEL,ORIG,DH,HT              LAT00510
      DOUBLE PRECISION  BETA,DDK,DHT,DORIG,D2,SV,MAXV,DR,DRD,ALPH       LAT00520
      DOUBLE PRECISION D1,DPI,DIST,H1,H2                                LAT00530
      INTEGER M,N,KK,QL,QR,KMAX,C1,C2,II,JJ,R,RD                        LAT00540
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCLAT00550
C    COMPUTE THE VALUE OF D                                            CLAT00560
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCLAT00570
      IF(J.NE.FLOAT(N))GO TO 10                                         LAT00580
         D=MPPLAT                                                       LAT00590
         GO TO 20                                                       LAT00600
10    D=SQRT(MPPLAT**2+(MPPLON/SH)**2)                                  LAT00610
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCLAT00620
C    SET KMAX TO THE NUMBER OF UNITS FROM M TO I                       CLAT00630
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCLAT00640
      KMAX=IABS(INT(FLOAT(M)-I))                                        LAT00650
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCLAT00660
C    ASSIGN VALUES FOR C1 AND C2 BASED ON RELATIVE POSITIONS OF SITE   CLAT00670
C AND CP.                                                             CLAT00680
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCLAT00690
      IF(KMAX.LT.1) GO TO 40                                            LAT00700
      IF(N-JJ.GE.0)GO TO 20                                             LAT00710
         C1=0                                                           LAT00720
         C2=1                                                           LAT00730
         GO TO 30                                                       LAT00740
 20   C1=1                                                              LAT00750
      C2=0                                                              LAT00760
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCLAT00770
C    BEGIN LOOP WHICH STEPS FROM THE CP TO THE SITE STOPPING AT EACH   CLAT00780
C SAMPLE POINT.                                                       CLAT00790
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCLAT00800
30    DO 40 K=1,KMAX                                                    LAT00810
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCLAT00820
C    ASSIGN THE SIGN OF KK BASED ON THE CP QUADRANT                    CLAT00830
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCLAT00840
         IF(M-II.LT.0)KK=K                                              LAT00850
         IF(M-II.GE.0)KK=-K                                             LAT00860
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCLAT00870
C    THIS SECTION CETERMINES THE LOCATION OF THE SAMPLE POINT, FINDS   CLAT00880
C THE MATRIX ELEMENTS IMMEDIATELY WEST AND EAST OF IT AND PERFORMS A   CLAT00890
C LINEAR INTERPOLATION TO ARRIVE AT THE SAMPLE POINT ELEVATION.        CLAT00900
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCLAT00910
         IF(N-C1-INT(FLOAT(KK)/SH).GE.1.AND.N+C2-INT(FLOAT(KK)/SH).LE.NMLAT00920
     *AX) GO TO 35                                                      LAT00930
               IF(N-C1-INT(FLOAT(KK)/SH).GE.1) GO TO 31                 LAT00940
                  HT=L(M+KK,N+C2-INT(FLOAT(KK)/SH))                     LAT00950
                  GO TO 60                                              LAT00960
```

```
31        HT=L(M+KK,N-C1-INT(FLOAT(KK)/SH))                                   LAT00970
          GO TO 60                                                            LAT00980
35      QL=L(M+KK,N-C1-INT(FLOAT(KK)/SH))                                     LAT00990
        QR=L(M+KK,N+C2-INT(FLOAT(KK)/SH))                                     LAT01000
        IF(ABS((FLOAT(KK)/SH)-FLOAT(INT(FLOAT(KK)/SH))).GT.1E-6)GO TO         LAT01010
     *50                                                                      LAT01020
          HT=(QL*C2)+(QR*C1)                                                  LAT01030
          GO TO 60                                                            LAT01040
50      HT=FLOAT(C1*QR+C2*QL)-(((FLOAT(KK)/SH)-FLOAT(INT(FLOAT(KK)/SH))LAT01050
     *)*FLOAT(QL-QR))                                                         LAT01060
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCLAT01070
C   ASSIGN THE VALUE OF 'DEL' BASED ON SIGN OF 'KK'                        CLAT01080
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCLAT01090
60      IF(KK.GT.0)DEL=DI                                                     LAT01100
        IF(KK.LT.0)DEL=1.0-DI                                                 LAT01110
        DK=D*(FLOAT(KMAX-K)+DEL)                                              LAT01120
        IF(DK.LT.50.0) GO TO 40                                               LAT01130
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCLAT01140
C   THIS SECTION CONVERTS SOME REAL VARIABLES TO DOUBLE PRECISION          CLAT01150
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCLAT01160
        DR=R                                                                  LAT01170
        DRD=RD                                                                LAT01180
        DDK=DK                                                                LAT01190
        D1=1.0D0                                                              LAT01200
        D2=2.0D0                                                              LAT01210
        DHT=HT                                                                LAT01220
        DPI=D2*DARSIN(D1)                                                     LAT01230
        DORIG=ORIG                                                            LAT01240
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCLAT01250
C   IF ANTENNA AND SAMPLE POINT ARE BOTH IN A DUCT USE DUCTING RADIUS.     CLAT01260
C IN EITHER CASE, COMPUTE ALPH AND DIST.                                   CLAT01270
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCLAT01280
        IF(ORIG.GT.DH.OR.HT.GT.DH) GO TO 65                                   LAT01290
          ALPH=DDK/(D2*DRD)                                                   LAT01300
          DIST=((D2*DRD)+DORIG+DHT)*DSIN(ALPH)                                LAT01310
          GO TO 70                                                            LAT01320
65      ALPH=DDK/(D2*DR)                                                      LAT01330
        DIST=((D2*DR)+DORIG+DHT)*DSIN(ALPH)                                   LAT01340
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCLAT01350
C   COMPUTE EQUIVALENT ELEVATIONS, BETA AND SV FOR THE SAMPLE POINT.       CLAT01360
C IF SV IS LARGER THAN MAXV, CHANGE MAXV TO EQUAL SV. LOOP TO NEXT         CLAT01370
C SAMPLE POINT AND REPEAT CALCULATIONS UNTIL REACHING SITE.                CLAT01380
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCLAT01390
70      H1=DORIG*DCOS(ALPH)                                                   LAT01400
        H2=DHT*DCOS(ALPH)                                                     LAT01410
        BETA=DATAN((H2-H1)/DIST)                                              LAT01420
        SV=(DPI/D2)+BETA-ALPH                                                 LAT01430
        IF(SV.GE.MAXV) MAXV=SV                                                LAT01440
```

```
 40   CONTINUE                                                          LAT01450
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCLAT01460
C     LOOP COMPLETE.  SEND VALUE OF MAXV BACK TO MAIN PROGRAM FOR COMPAR CLAT01470
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCLAT01480
      RETURN                                                            LAT01490
      END                                                               LAT01500
```

```
      SUBROUTINE LONSCN( MPPLON,MPPLAT,I,J,M,N,SH,ORIG,MAXV,R,MMAX,II,JJ,LON00010
     *DJ,RD,DH)                                                          LON00020
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCLON00030
C     THIS IS THE 'LONSCN' SUBROUTINE.  IT HAS A LOGIC FLOW WHICH IS    CLON00040
C IDENTICAL TO 'LATSCN', EXCEPT THAT IT SCANS THE MATRIX GENERALLY IN  CLON00050
C AN EAST-WEST DIRECTION INSTEAD OF NORTH-SOUTH.  DUE TO THE SIMILARI- CLON00060
C TIES BETWEEN THE TWO, 'LONSCN' WILL NOT BE ANNOTATED.  THE VARIABLE CLON00070
C LISTING IS ALSO OMITTED SINCE THE ONLY CHANGE IN VARIABLES IS THAT A CLON00080
C FEW OF THEM USE 'L' INSTEAD OF 'K' IN THE NAME.                      CLON00090
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCLON00100
      INTEGER*2     L(400,400)                                          LON00110
      COMMON   L                                                        LON00120
      REAL      MPPLON,MPPLAT,SH,D,DL,HT,I,J,DJ,DEL,ORIG,DH             LON00130
      DOUBLE PRECISION   BETA,DDL,DHT,DORIG,D2,SV,MAXV,DR,DRD,ALPH      LON00140
      DOUBLE PRECISION D1,DPI,DIST,H1,H2                                LON00150
      INTEGER M,N,K,LL,PU,PL,LMAX,C1,C2,II,JJ,R,RD                      LON00160
      IF(I.NE.FLOAT(M))GO TO 10                                         LON00170
         D=MPPLON                                                       LON00180
         GO TO 20                                                       LON00190
10    D= SQRT(MPPLON**2+( SH*MPPLAT)**2)                                LON00200
      LMAX=IABS(INT(FLOAT(N)-J))                                        LON00210
      IF(LMAX.LT.1) GO TO 40                                            LON00220
      IF(M-II.GE.0) GO TO 20                                            LON00230
         C1=0                                                           LON00240
         C2=1                                                           LON00250
         GO TO 30                                                       LON00260
20    C1=1                                                              LON00270
      C2=0                                                              LON00280
30    DO 40 K=1,LMAX                                                    LON00290
         IF(N-JJ.LT.0)LL=K                                              LON00300
         IF(N-JJ.GE.0)LL=-K                                             LON00310
         IF(M-C1-INT(FLOAT(LL)*SH).GE.1.AND.M+C2-INT(FLOAT(LL)*SH).LE.MMLON00320
     *AX) GO TO 35                                                      LON00330
               IF(M-C1-INT(FLOAT(LL)*SH).GE.1) GO TO 31                 LON00340
                  HT=L(M+C2-INT(FLOAT(LL)*SH),N+LL)                     LON00350
                  GO TO 60                                              LON00360
31             HT=L(M-C1-INT(FLOAT(LL)*SH),N+LL)                        LON00370
               GO TO 60                                                 LON00380
35          PU=L(M-C1-INT(FLOAT(LL)*SH),N+LL)                           LON00390
            PL=L(M+C2-INT(FLOAT(LL)*SH),N+LL)                           LON00400
            IF(ABS((SH*FLOAT(LL))-FLOAT(INT(SH*FLOAT(LL)))).GT.1E-6) GO TO LON00410
     *50                                                                LON00420
               HT=(PU*C2)+(PL*C1)                                       LON00430
               GO TO 60                                                 LON00440
50          HT=FLOAT(C1*PL+C2*PU)-(((FLOAT(LL)*SH)-FLOAT(INT(FLOAT(LL)*SH))LON00450
     *)*FLOAT(PL-PU))                                                   LON00460
60          IF(LL.GT.0)DEL=DJ                                           LON00470
            IF(LL.LT.0)DEL=1.0-DJ                                       LON00480
```

```
      DL=D*(FLCAT(LMAX-K)+DEL)
      IF(DL.LT.50.0) GO TO 40
      DDL=DL
      D1=1.0D0
      D2=2.0D0
      DR=R
      DRD=RD
      DHT=HT
      DPI=D2*DARSIN(D1)
      DORIG=ORIG
      IF(ORIG.GT.DH.OR.HT.GT.[illegible]  GO TO 65
         ALPH=DDL/(D2*DRD)
         DIST=((D2*DRD)+DORIG+DHT)*DSIN(ALPH)
         GO TO 70
65    ALPH=DDL/(D2*DR)
      DIST=((D2*DR)+DORIG+DHT)*DSIN(ALPH)
70    H1=DORIG*DCOS(ALPH)
      H2=DHT*DCOS(ALPH)
      BETA=DATAN((H2-H1)/DIST)
      SV=(DPI/D2)+BETA-ALPH
      IF(SV.GE.MAXV) MAXV=SV
40    CONTINUE
      RETURN
      END
```

```
      SUBROUTINE COMPAR(MAXV,R,M,N,ORIG,D,HT,AGL,MSL,DM,DN,DISRES,K,KMAX
     *,II,JJ,RD,DH)
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C    THIS IS THE 'COMPAR' SUBROUTINE.  IT USES MAXV TO COMPUTE A MASK-  C
C HEIGHT ABOVE THE CP.  IT THEN COMPARES THIS VALUE TO THE INPUT AGL    C
C AND MSL STRIKE ALTITUDES.  BASED ON THIS, IT ASSIGNS AN INDICATOR     C
C VARIABLE TO THE POSITION OF THE CP IN THE DISPLAY MATRICES.  THESE    C
C INDICATOR VARIABLES ARE THEN MANIPULATED BY THE MAIN PROGRAM TO FORM C
C THE AGL AND MSL MASKING ENVELOPES.                                    C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C                                                                       C
C     VARIABLE LISTING.  ONLY THOSE VARIABLES NOT CONTAINED IN THE      C
C MAIN PROGRAM OR IN LATSCN ARE EXPLAINED BELOW.                        C
C                                                                       C
C     NAME     TYPE                  FUNCTION                           C
C                                                                       C
C     A         DP     DISTANCE FROM THE EARTH'S CENTER TO THE MASKING  C
C                      HEIGHT ABOVE THE CP                              C
C     ADET      I      TEMPORARY VALUE FOR MASKING INDICATOR VARIABLE   C
C     BB        DP     THE ANGLE SUBTENDED BY THE GROUND DISTANCE FROM THE C
C                      SITE TO THE CP                                   C
C     C         DP     DISTANCE FROM THE EARTH'S CENTER TO THE ANTENNA  C
C     CC        DP     ANGLE EQUIVALENT TO PI MINUS THE SUM OF MAXV AND BB C
C     DD        DP     GROUND DISTANCE FROM SITE TO CP                  C
C     DELTA     I      INTERVAL FROM THE SITE WITHIN WHICH THE DISPLAY  C
C                      WILL TAKE ON THE VALUE OF THE SITE NUMBER        C
C     FH        R      REAL VALUE FOR ELEVATION AT THE CP               C
C     KK        I      INDEX VARIABLE WHICH INCREMENTS SITE NUMBERS     C
C     KEEPA     I      INDICATOR VARIABLE WHICH DETERMINES WHETHER OR NOT C
C                      AN AGL DISPLAY MATRIX ELEMENT VALUE CAN BE CHANGED C
C     KEEPM     I      SAME AS 'KEEPA' FOR MSL DISPLAY MATRIX           C
C     MDET      I      SAME AS ADET FOR MSL DISPLAY MATRIX              C
C     MHA       R      MASKING HEIGHT IN METERS AGL AT THE CP           C
C     MHM       R      MASKING HEIGHT IN METERS MSL AT THE CP           C
C     RR        I      TEMPORARY HOLDING VARIABLE FOR VALUE OF 'R'      C
C     S         I      VECTOR OF SYMBOLS USED FOR DISPLAYED SITE NUMBERS C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      INTEGER*2    L(400,400)
      COMMON   L,IADIS(80,80),IMDIS(80,80)
      DOUBLE PRECISION  D1,D2,DPI,BB,CC,DR,DD,DORIG,MAXV,A,C
      REAL     DH,ORIG,AGL,MSL,MHM,MHA,FH
      INTEGER HT,MDET,ADET,DM,DN,KEEPA,KEEPM,II,JJ
      INTEGER X/' '/,O/'0'/,Z/'.'/,DISRES,V/'9'/,K,S(9),KK,KMAX,DELTA
      INTEGER E/'1'/,F/'2'/,G/'3'/,H/'4'/,P/'5'/,Q/'6'/,T/'7'/,U/'8'/
      INTEGER RD,R,RR
      FH=FLOAT(HT)
      RR=R
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
```

```
C     INITIALIZE THE SITE NUMBER VECTOR
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      S(1)=E
      S(2)=F
      S(3)=G
      S(4)=H
      S(5)=P
      S(6)=Q
      S(7)=T
      S(8)=U
      S(9)=V
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C     INITIALLY ALLOW ALL ELEMENTS TO BE CHANGED
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      KEEPM=0
      KEEPA=0
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C     IF THE ELEMENT HAS BEEN PREVIOUSLY ASSIGNED AN UNMASKED CONDITION
C     OR HAS BEEN ASSIGNED AS A SITE NUMBER IT MAY NOT BE CHANGED
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      DO 1 KK=1,KMAX
      IF(IMDIS(DM,DN).EQ.X.OR.IMDIS(DM,DN).EQ.S(KK)) KEEPM=1
      IF(IADIS(DM,DN).EQ.X.OR.IADIS(DM,DN).EQ.S(KK)) KEEPA=1
    1 CONTINUE
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C     ASSIGN SITE NUMBER CODE TO APPROPRIATE POSITION IN MATRIX
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      DELTA=(DISRES/2)+1
      IF(IABS(N-II).LE.DELTA.AND.IABS(N-JJ).LE.DELTA) GO TO 40
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C     IF ANTENNA AND AGL STRIKE ALTITUDE ARE IN DUCT USE DUCTING RADIUS
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      IF(ORIG.LE.DH.AND.(FH+AGL).LE.DH) R=RD
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C     CONVERT REAL VALUED VARIABLES TO DOUBLE PRECISION
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      DR=R
      DD=D
      DORIG=ORIG
      D1=1.0D0
      D2=2.0D0
      DPI=D2*DARSIN(D1)
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C     COMPUTE MHA AND MHM
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      BB=DD/DR
      CC=DPI-(MAXV+BB)
      C=DORIG+DR
```

```
      A=(C*DSIN(MAXV))/DSIN(CC)                                         COM00970
      MHM=A-DR                                                          COM00980
      R=RR                                                              COM00990
      IF(MHM.LE.FH)MHM=FH                                               COM01000
      MHA=MHM-FH                                                        COM01010
      IF(MHA.LE.0.0001D0)MHA=0.0D0                                      COM01020
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCOM01030
C    COMPARE AGL AND MSL TO MHA AND MHM.  ASSIGN CODES TO INDICATE THE  CCOM01040
C MASKING CONDITION AT THE CP.  ALSO INDICATE IF TERRAIN EXCEEDS THE   CCOM01050
C STRIKE ALTITUDE FOR THE MSL DISPLAY.                                 CCOM01060
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCOM01070
      IF(MSL.GT.FH) GO TO 5                                             COM01080
         MDET=0                                                         COM01090
         GO TO 20                                                       COM01100
 5    IF(MHM.GT.MSL) GO TO 10                                           COM01110
         MDET=X                                                         COM01120
         GO TO 20                                                       COM01130
10    MDET=Z                                                            COM01140
20    IF(MHA.GT.AGL) GO TO 30                                           COM01150
         ADET=X                                                         COM01160
         GO TO 50                                                       COM01170
30    ADET=Z                                                            COM01180
         GO TO 50                                                       COM01190
40    IMDIS(DM,DN)=S(K)                                                 COM01200
      IADIS(DM,DN)=S(K)                                                 COM01210
         GO TO 60                                                       COM01220
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCOM01230
C    DEPENDING ON 'KEEPA' AND 'KEEPM' CHANGE THE MATRIX ELEMENT VALUES  CCOM01240
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCOM01250
50    IF(KEEPM.EQ.1) GO TO 55                                           COM01260
      IMDIS(DM,DN)=MDET                                                 COM01270
55    IF(KEEPA.EQ.1) GO TO 60                                           COM01280
      IADIS(DM,DN)=ADET                                                 COM01290
60    CONTINUE                                                          COM01300
      RETURN                                                            COM01310
      END                                                               COM01320
```

```
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C     THIS IS THE 'IRND' FUNCTION.  IT PERFORMS CONVERSION OF REAL NUM-  C
C  BERS TO INTEGERS BY ROUNDING TO THE NEAREST INTEGER VALUE.  NO EXPLA-C
C  NATION OF THE CODE IS OFFERED DUE TO ITS SIMPLICITY.                 C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      FUNCTION IRND(X)
      REAL    X
      INTEGER IRND,A
      A=INT(X)
      IF(X-A.GE.0.5)GO TO 10
         IRND=A
         GO TO 20
10    IRND=A+1
20    CONTINUE
      RETURN
      END
```

```
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCRAD00010
C     THIS IS THE 'RAD' FUNCTION.  IT CONVERTS ANGULAR MEASURE IN ARC-  CRAD00020
C  SECONDS TO RADIANS.  NO DETAILED EXPLANATION OF THE CODE IS OFFERED  CRAD00030
C  DUE TO THE SIMPLICITY OF IT.                                         CRAD00040
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCRAD00050
      FUNCTION RAD(X)                                                   RAD00060
      REAL      A,PI,RAD                                                RAD00070
      INTEGER X                                                         RAD00080
      A=FLOAT(IASEC(X))/3600.0                                          RAD00090
      PI=2.0*ARSIN(1.0)                                                 RAD00100
      RAD=(A*2.0*PI)/360.0                                              RAD00110
      RETURN                                                            RAD00120
      END                                                               RAD00130
```

```
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C    THIS IS THE 'IASEC' FUNCTION.  IT CONVERTS ANGULAR MEASURE GIVEN   C
C IN DEGREES, MINUTES AND SECONDS TO SIMPLY SECONDS.  NO DETAILED EX-  C
C PLANATION OF THE CODE IS OFFERED DUE TO ITS SIMPLICITY.CCCCCCCCCCCCCCC
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      FUNCTION IASEC(DMS)
      INTEGER DMS,MIN,SEC,DEG,IASEC
      DEG=DMS/10000
      MIN=(DMS-(DEG*10000))/100
      SEC=DMS-((DEG*10000)+(MIN*100))
      IASEC=SEC+(60*MIN)+(3600*DEG)
      RETURN
      END
```

LIST OF REFERENCES

1. Attwood, S.S. and others, The Propagation of Radio Waves Through the Standard Atmosphere, Columbia University Press, 1946.

2. Defense Mapping Agency, Catalogue of Digital Data, 1982.

3. Defense Mapping Agency, Product Specifications for DMA Standard for Digital Terrain Elevation Data, 1977.

4. Long, M.W., Radar Reflectivity of Land and Sea, Heath, 1975.

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